ISSN 0100-2945 http://dx.doi.org/10.1590/0100-29452017950

EVALUATION OF NITROGEN MONITORING, BUD FERTILITYAND 'THOMPSON SEEDLESS' GRAPEVINE PRODUCTION ON DIFFERENT ROOTSTOCKS[1]

EMANUEL ALMEIDA MARTINEZ[2], VALTEMIR GONÇALVES RIBEIRO[3], PATRÍCIA FERNANDA INÁCIO VILAR[4], LEANDRO JOSÉ DE OLIVEIRA VON HAUSEN[5], ERIANE DANTAS BEZERRA[6]

ABSTRACT– Methods of nitrogen analysis were adopted in leaf tissues in the laboratory, nitrate content in the sap of petioles and chlorophyll relative index (CRI, in SPAD unit), as well as the evaluation of the buds fertility rates, production and qualitative aspects of cluster and berries of 'Thompson Seedless' vine, grafted on rootstocks 'Harmony', 'Jales' 'Paulsen 1103' and 'SO4'. The applied dose of N was 80 kg ha^{-1}, and the experiment was installed in the Submédio do Vale do São Francisco, Brazil. The experiment was performed in a randomized blocks design, with four treatments and five replicates, with the experimental plot represented by five plants. In addition to the analysis of N, cluster length and width (cm) and fresh mass (g), berries length, diameter (mm), volume (mL), mass of fresh matter of berries, soluble solids (SS), titratable acidity (TA), SS/TA ratio, potential bud fertility (productive, vegetative, dead and dark buds in %) and real bud fertility (%). There were differences in nitrogen content in the leaves, nitrate in sap and CRI of 'Thompson Seedless' in relation to rootstocks. 'Thompson Seedless' expressed better potential for the development of clusters and berries when grafted on 'Harmony'.

Index terms: *Vitis vinifera* (L.); plant nutrition; buds fertility; viticultura tropical irrigada

AVALIAÇÃO DE NITROGÊNIO, FERTILIDADE DE GEMAS E PRODUÇÃO DA VIDEIRA 'THOMPSON SEEDLESS' SOBRE DIFERENTES PORTA-ENXERTOS

RESUMO - Adotaram-se métodos de análise de N em tecidos de folhas em laboratório, teores de nitrato na seiva de pecíolos e o índice relativo de clorofila (IRC, em unidade SPAD), bem como foram avaliados as taxas de fertilidade de gemas, os aspectos produtivos e qualitativos de cachos e bagas da videira 'Thompson Seedless', enxertada sobre os porta-enxertos 'Harmony', 'Jales' 'Paulsen 1103' e 'SO4'. A dose de N aplicada foi de 80 kg ha^{-1}, e o experimento foi instalado no Submédio do Vale do São Francisco, Brasil. O delineamento experimental utilizado foi blocos ao acaso, com quatro tratamentos e cinco repetições, sendo que a parcela experimental foi constituída por cinco plantas. Além das análises de N pelos métodos citados, avaliaram-se comprimento e largura (cm) e massa fresca de cacho (g), comprimento, diâmetro (mm), volume (mL), massa da matéria fresca de bagas (g), teor de sólidos solúveis (SS), acidez titulável (AT), relação SS/AT, fertilidade de gemas potencial (gemas frutíferas, vegetativas, mortas e escuras, em %) e fertilidade de gemas real (%). Verificaram-se diferenças entre teores de nitrogênio na folha, nitrato na seiva e IRC da 'Thompson Seedless' em relação aos porta-enxertos, e quando enxertada sobre o 'Harmony', a 'Thompson Seedless' expressou melhor potencial para o desenvolvimento de cachos e bagas.

Termos para indexação: *Vitis vinifera* (L.); nutrição de plantas; fertilidade de gemas; viticultura tropical irrigada. .

[1](Paper 069-16). Received May 18, 2016. Accepted August 30, 2017.

[2]Agronomist, Master in Agronomy: Irrigated Horticulture. State University of Bahia. Research extracted from the Master's dissertation of the first author, from the Post-graduate Program in Agronomy: Irrigated Horticulture. E-mail: ealmartinez86@gmail.com
[3]Agronomist, PhD Titular Professor. State University of Bahia. Juazeiro-BA. E-mail: vribeiro@uneb.br
[4]Agronomist, Master Federal Education Institute of Maranhão. E-mail: pfivilar@hotmail.com
[5]Agronomist, Master in science and Technology of seeds. E-mail: leandrohausen@yahoo.com
[6]Master in Natural Resources of the Semi-Arid. E-mail:eri.saude@hotmail.com

INTRODUCTION

Vale do Submédio de São Francisco is located in a region of tropical semi-arid climate, characterized by its high temperature and low relative humidity, with about 120 irrigable hectares, in which there are 25 irrigated public projects in operation (LEÃO and MOUTINHO, 2014). In this area, there are the municipalities of Petrolina, Lagoa Grande, Santa Maria da Boa Vista in the state of Pernambuco, and Juazeiro, Casa Nova, Curaçá, Sobradinho and Sento Sé, in Bahia state, in a planted area of 9.036 hectares of vines and average yield of 32.474,70 kg ha^{-1} (IBGE , 2012).

Among the macronutrients, nitrogen (N) is the nutrient of greatest demand for the vine, being absorbed from the soil solution in the mineral form, such as nitrate (NO_3^-) and ammonium ($NH4^+$). In extreme deficiency conditions, there is the absorption of organic nitrogen compounds, but without supplying the plant's demand (ROCHA et al., 2015).

The use of methods of nitrogen diagnosis in vines is of utmost importance, in order to maximize yields, reduce costs of nitrogen fertilizer and reduce environmental impacts caused by excessive fertilizers use.

The chlorophyll relative index in the leaves is a measure that can be used to evaluate the level of nitrogen in plants, since its quantity correlates positively with the nutrient levels in the plant tissue. This determination is made by a chlorophyll meter, and it is a method of early diagnosis of N deficiency, performed quickly, instantaneously and non-destructively (SOUZA et al., 2016).

Studies have demonstrated the beneficial effect of the use of rootstocks on the control of vegetative vigor, resistance to diseases and drought, and tolerance to waterlogged and saline soils in the production of cultivated species (BILLONES-BAAIJENS et al., 2014; JOGAIAH et al., 2014; MUROLO; ROMANAZZI, 2014; SERRA et al., 2014; TSEGAY et al., 2014).

In Urussanga-SC, research results showed higher yield of 'Niagara Rosada' when grafted onto 'Paulsen 1103', 'Dog Ridge', 'Campinas' and 'Tropical' rootstocks; and 'Dog Ridge', despite the high yield, was not recommended for the production of grapes for consumption in natura, due to the badly formed clusters, with very spaced berries, with no commercial value. On the other hand, 'Jales' and 'Campinas' presented good yield and compact clusters with good size, even though there were greenish berries that depreciate their commercial value (BRUNA;BACK, 2015).

Thus, the aim of this work was to evaluate the nitrogen (N) contents in 'Thompson Seedless' vine grafted on 'Harmony', 'Jales' 'Paulsen 1103' and 'SO4' rootstocks. For this purpose, it was evaluated methods of analysis of N in leaf tissues in the laboratory, nitrate levels in the petioles saps and chlorophyll relative index (CRI in SPAD unit), bud fertility and clusters and berries yield and qualitative aspects.

MATERIAL E METHODS

The experiment was carried out in a commercial area of the Farm Brasil Uvas Agrícola Ltda., located in the city of Juazeiro, Bahia, 09º 19'30,04 "S and 40 11'41,41" W, with an altitude of 400 m. During the experiment period, between the months of June and November of 2012, it was recorded a rainfall of 14.6 mm and an average temperature of 26.8ºC, with minimum of 20.5ºC and maximum of 33°C.

In the experimental area there were 'Thompson Seedless' vines in vineyard with an average age of four years old, spacing of 3.5 m x 2.0 m, in trelis system type "Y", grafted on '' Harmony "," Jales ", " Paulsen 1103 " and "SO4" rootstocks. The irrigation system has double rows of drippers spaced with 0.5 m in plant line, with an average flow of 1.25 L h^{-1}, with the irrigation depth applied being determined taking into consideration the crop coefficient (kc) and the average of the potential evapotranspiration of the last three days recorded by the weather station model "Vantage Pro 2" Davis®. The soil of the experimental area presented a medium texture and was classified as Yellow Argisoil and presented the following chemical attributes at 0-30 cm depth: pH ($CaCl_2$) 6,3; OM (g dm^{-3}) 29; P (mg dm^{-3}) 477; EC (dS m^{-}) 1,18; K^+ (mmol dm^{-3}) 10,9; Ca^{2+} (mmol dm^{-3}) 31; Mg^{2+} (mmol dm^{-3}) 28; Al^{++} (mmol dm^{-3}) 0; H+Al (mmol dm^{-3}) 10; SB (mmol dm^{-3}) 69,9; T (mmol dm^{-3}) 79,9; V (%) 87.

The experiment was performed in a randomized blocks design, consisting of four rootstocks to 'Thompson Seedless': 'Harmony ',' SO4 ',' Jales', 'Paulsen 1103 ', and 'SO4' and five replicates, with the experimental plot consisting of five plants. It was applied 80 kg ha^{-1} of N , 50% in the form of urea (45% N) and ammonium sulfate, with the commercial Amiorgan® product (17% N) as source and 50% in the form of calcium nitrate (15% N) applied from the budding until the pre-softening of berries, dividing into dosages of 40 kg ha^{-1} N until full bloom stage (divided into 4 applications with 7-day interval).

The monitoring of climatic elements in the experimental area was carried out by gathering information from the meteorological station of the farm where the experiment was performed. The following variables were analyzed: N content in the plant leaf tissue (g kg^{-1}); chlorophyll relative index (CRI); sap nitrate concentration (mg L^{-1}); cluster length and width (cm); berries fresh mass (g), length (mm) diameter (mm), volume (ml) e berries fresh mass (g); SS-soluble solids content (ºBrix); Titratable acidity-TA (% tartaric acid); (SS / TA) ratio; potential fertility of buds (fertile, vegetative, dead and dark buds, in %) and real fertility of buds (%).

In order to determine the CRI and N contents in the leaves and sap nitrate, each plant was divided into three parts (basal, median and apical), from which two leaves were collected, one on the right side and one on the left side, totaling six leaves per plant, showing a complete maturation degree, free from pest attack and opposite positioned the clusters, totaling 30 leaves per experimental plot.

The CRI (SPAD unit) was obtained with the use of a portable chlorophyll meter (SPAD-502, Minolta, Japan). The chlorophyllometer has diodes that emit radiation at 650 nm (red light) and 940 nm (infrared radiation). During the measurement, the light passes through the leaf and is received by a silicon photodiode, where it is converted into signals that pass by a microprocessor which calculates proportional values to the chlorophyll content value in the leaf (MINOLTA, 1989). The Chlorophyll analysis was performed with the leaves before collection to perform further analyses: sap and leaf chemical analysis in the laboratory.

To sap analysis, it was used the same leaves subjected to the CRI reading, and collected two leaves in basal, middle and apical axis of plants arranged on opposite sides, with complete maturation degree and free of pest attack, all opposing the clusters, totaling 30 leaves in the experimental plot. The petioles were separated from the limbus and used for sap analysis. The sap extraction was performed by a hydraulic press, collecting one mL using a disposable syringe to read the NO_3^- contents, using Cardy Meter portable meters equipped with ion-sensitive microelectrodes. The analyzes of NO_3^- in the petiole sap and CRI were made in the phenological stages of full bloom, pre-softening and vegetative dormancy of the vines.

In the farm laboratory, the petioles were subjected to an extraction process through a hydraulic press to sap removal, collecting one mL through a disposable syringe for reading NO_3^- content reading, using the portable meters Cardy Meter equipped with microelectrodes that are sensitive to nitrate.

To determine the nitrogen content in the whole leaf (blade + petiole) at the bloom period, the blade and the petiole, after blade press were placed in paper bags and taken to the Soil and Plant Analysis Laboratory (LASP, located in Petrolina-PE), to identify the nitrogen content in the plant tissue. In order to determine nitrogen contents in the whole leaf during the full bloom period, the limbus and the petiole - after washing in distilled water and petiole pressing - were placed in a paper bag.

For biometric and chemical analysis it was used the methodology adopted by Villar et al. (2013), by collecting cluster per plant, totaling five clusters per plot, with representative similar lengths, of which 10 berries were removed, being four from the top, four from the middle and two from the bottom. The clusters length and width were determined with the aid of graduated ruler in centimeters. To determine the clusters length, readings were performed from the insertion of the first branch to the end of the cluster; for the width determination, readings were taken from one end to another in the first clusters.

To determine berries length and diameter, they were arranged one after another in a row over an measuring tape graduated in millimeters. By the division reading verified on tape, after arrangement of 100 berries on upright (diameter) and horizontal (length) positions, the mean values of these two variables were obtained. The following variables were also evaluated: the mass of cluster and berries fresh matter (g) in a Filizolla® accurate digital scale, and the berry volume (measured in a test tube, after the introduction of 50 berries, calculating the displaced volume / 50, in ml).

To determine the SS content (° Brix) and TA (g tartaric acid / 100 g of pulp), four berries were collected from each cluster, one from the top, two from the median part and a one from the lower part, totaling 20 berries per replicate. Then, the berries were manually pressed in order to extract the grape must. To determine the SS content it was used a manual refractometer (Instrutherm), and determine TA, the titrimetric method with 0.1 N NaOH solution was used.

To determine the potential fertility of buds (percentage of fertile, vegetative, dead and dark bud) it was removed three branches in each plant from the useful area, divided equally into three parts: basal, middle and apical, totaling 15 branches per replication, each branch consisting of 13 buds. After collection, the leaves were removed, forming bundles, which were wrapped in transparent plastic film that is used to wrap foods in order to avoid dehydration. Later, the bundles were transported to the laboratory to perform the bud fertility analysis. The bud analyses were carried out using magnifying glass binocular loupe 30 times, scalpel handle with blade number 11 and forceps (VILAR, et al., 2017).

For the determination of the percentages of real buds fertility, the number of buds sprouted and the number of buds sprouted with cluster were quantified in the plant 20 days after pruning. The real fertility was obtained in the vineyard after budding, with the visualization of the clusters, through the relation: number of clusters emitted per bud / total number of buds sprouted per plant (VILAR et al., 2017).

The observed data were submitted to analysis of variance and means were compared by the Tukey test ($p <0.05$) and by estimations of correlation coefficients by the Pearson method, (ρ).

RESULTS AND DISCUSSION

There were positive correlations between the N content in the leaf (limb + petiole) with the nitrate content in the sap of the petiole ($\rho = 0.5268$) and with the CRI ($\rho = 0.4903$). There was also a strong correlation between the nitrate content in the sap of the petiole and the CRI ($\rho = 0.7542$).

These results are in accordance to Souza et al. (2011) that also obtained a positive correlation between CRI and the N content in citric plants; Machado et al. (2010) observed a positive and significant correlation between CRI and the nitrate content in 'Niagara Rosada' vine petiole sap. The rootstocks 'Harmony', 'SO4', 'Jales' and 'Paulsen 1103' influenced the nitrogen content in the leaf (on full bloom) and nitrate in petiole sap (full bloom, berries pre-softening and dormancy) for 'Thompson Seedless' vines (Table 1).

Despite the low nitrate content in the petiole sap (2.126 mg L^{-1}) during dormancy, the 'Thompson Seedless" grafted on 'Jales' presented higher nitrate content on full bloom (1.859 mg L^{-1}) and during barriers pre-softening (5.166 ppm)., as well as higher nitrogen concentration in the leafs (54.18 g/kg). This result can be justified by the easy adjustment of this rootstock on different soil types and for the high vigor that facilitates the N accumulation. In a study conducted by Tecchio et al. (2007) a higher N extraction by the IAC572 'Jales' rootstock on 'Niagara Rosada' was also observed.

Regarding the nitrate in petiole sap content, 'Jales' and 'Harmony' rootstocks presented similar and statistically higher amounts than 'SO4' that presented the lower value. The founded results are explained by the study conducted by Machado et al. (2010) that observed a higher nitrate content in the sap of 'Jales' rootstock on 'Niagara Rosada' during full bloom, when compared to other rootstocks (IAC-766 'Campinas', IAC-571-6 'Jundiaí', IAC-313 'Tropical'). Tecchio et al. (2007), Csikász-krizsics and Diófási (2008) and Miele et al. (2009) also obtained significant variations on the nutrient leaf contents of the studied rootstocks.

According to Table 1, a statistical difference was observed on the nitrate content during the dormancy phase, with 'Harmony', 'SO4' and 'Paulsen 1103' rootstocks presenting higher amounts than IAC-572 ('Jales'). It is probably due to the higher vegetative growth of the last one, during vegetative dormancy, resulting in a higher nitrate metabolism on the sap of shoot parts.

For the variable CRI (Table 2), it was observed that during the full bloom phase, 'Jales' presented higher results than 'SO4' and 'Paulsen 1103' rootstocks. Machado et al. (2010) observed a higher CRI on 'Niagara Rosada' vine grafted on 'IAC 766', when compared to 'IAC 572', 'IAC 313', '571-6' and 'Ripária do Traviú' rootstocks. During the berries pre-softening phase, 'Harmony' was superior to 'SO4' and 'Paulsen 1103'rootstocks. During the dormancy phase, no statistical difference was observed between rootstocks, due to a metabolism reduction and probably due to the beginning of senescence on the evaluated leaves.

For the variables related to the fertility of 'Thompson Seedless' buds grafted on the different rootstocks, there were rootstock influences, as evidenced in Table 3. Analyzing the percentage of fertile buds, it was observed that the 'SO4' and 'Harmony' rootstocks showed the best results, differing statistically from the 'Jales' rootstock. Considering the percentage of vegetative buds, it was observed that there was no statistical difference between the treatments, and the same was observed for dead buds. Comparing the percentage of dark buds, it is observed that the 'Jales' rootstock presented the highest value, differing statistically from the 'Harmony' rootstock.

In relation to the real fertility values (Table 3), the 'SO4' rootstock presented the highest value, but statistically similar to the 'Harmony' rootstock. However, differing statistically from the 'Jales' rootstocks and 'Paulsen 1103'. Studying the real fertility of 'Thompson Seedless' buds grafted on 'Ramsey', Vilar et al. (2017) verified a rate of 44.59%, which shows the variations of buds fertility rates that different rootstocks may induce.

These results can be explained by the characteristic of IAC-572 ('Jales') in being a high vigor rootstock (GIOVANNINI, 2014) and some varieties grafted on it have different development, interfering with the fertility and the accumulation of reserves (SOUZA et al., 2015), and that the excessive vigor of the branches tends to reduce the fertility of buds in vines (SANTOS et al., 2016).

The greater the apical dominance of the branches, the greater is the excess of leaves in the canopy of the plant that will hinder the solar penetration on the buds, compromising the floral differentiation. On the other hand, different amounts of leaves may also alter the carbohydrate contents in vine shoots and buds (SOUZA et al., 2013). However, there is a positive correlation between the total soluble sugars and starch with the potential fertility (SOUZA et al., 2011). Carbon stocks tend to favor the percentage of fertile buds (ROSA et al. 2014).

A study performed by Melo and Ribeiro (2012) at the Submédio do Vale do São Francisco (Petrolina-PE), with 'Superior Seedless' grafted on 'Harmony' and IAC-766 ('Campinas') rootstocks, showed that 'Harmony' promoted a shorter internode length of 'Superior Seedless' vine branches, which can be considered as an indicative of vigor reduction, promoted by the combination rootstock/canopy. However, the study also concluded that 'Harmony' induced a high bud fertility when compared to IAC-766 'Campinas', reaching values of 29.46% and 6.79% of fertile buds, respectively.

For the evaluated variables of production, specifically for clusters characteristics, there was an effect of the rootstocks (Table 4), and for length and fresh mass, the plants grafted on the 'Harmony' rootstock presented higher values than those obtained with the other rootstocks, and for the cluster length (cm) was superior to 'Jales' and 'Paulsen 1103' rootstocks.

For the variables related to the characteristics of berries, there were rootstock (Table 5). Analyzing CL, CFM and VB, it was observed that the plants grafted on the 'Harmony' rootstock had higher average values, being superior to the other rootstocks. This fact can be justified by the fact that this rootstock shows less vigor to the canopy (LEÃO et al., 2011), favoring better assimilation and distribution of nitrogen. Thus, the content of this nutrient in the leaves has great influence in the expression of genes for the synthesis of carboxylic enzymes (ribulose 1,5-bisphosphate carboxylase, Rubisco and phosphoenol-pyruvate carboxylase, PEPcase).

For the berries diameter, the rootstocks 'Harmony', 'Paulsen 1103' and 'Jales' did not differed statistically and the rootstock 'SO4' presented the lower value for this variable. Leão et al. (2011), in a study with cv. Sugraone on four rootstocks observed that 'Harmony', 'SO4' and 'Paulsen 1103' did dot differ statistically and were superior to '420-A', confirming the higher berry diameter expressed by 'Harmony' and 'Paulsen 1103' rootstocks. In a study performed by Brighenti et al. (2011), the rootstocks 'Paulsen 1103' also showed higher berry diameter.

There was also a rootstock influence for the variables soluble solids (SS), total acidity (TA) and the SS/TA ratio (Figures 1, 2 and 3).

For the variable soluble solids, it was observed that the 'SO4' rootstock presented the highest value, differing statistically from the other rootstocks. Rootstocks with a moderate vigor tend to have a better source/drain ratio, facilitating the translocation of photoassimilates and nutrients, such as potassium to the fruit. Leão et al. (2011) observed that the use of the rootstock 'Paulsen 1103' led to a higher amount of soluble solids in berries of the 'Superior Seedless' vine.

For the variable titratable acidity, the rootstock 'Jales' was statistically superior to 'SO4' and 'Harmony'. In studies carried out in the municipality of Santo-Sé-BA, during four production cycles (2002 to 2004) with 'Sugraone' grafted on rootstocks 'Paulsen 1103', 'SO4', 'Harmony' and '420A', Leão et al. (2011) verified that there was no influence of rootstocks on total acidity of the berries.

For the variable SS/AT ratio there was a statistical difference between the treatments, and the rootstock 'SO4' was statistically superior to 'Harmony', 'Jales' and 'Paulsen 1103', due to its higher soluble solids content and lower titratable acidity. On the other hand, Leão et al. (2011) did not witness the influence of the above-mentioned rootstocks on the SS/AT ratio of berries.

TABLE 1 - Nitrogen content (N) in the leaf and nitrate (NO-3) in the sap of the 'Thompson Seedless' grapevine at the phenological stages of full bloom, pre-softening of berries and dormency on rootstocks 'Harmony', 'SO4', 'Jales' and 'Paulsen 1103', in a commercial area in the Vale do São Francisco .

	N content in the leaf (g kg^{-1})	NO^-_3 in the sap (mg L^{-1})		
Rootstocks	Full bloom	Full bloom	Pre-softening	Dormency
'Harmony'	49.78b	1789.01a	1798.47b	3306.29a
'SO4'	47.12bc	832.42b	1365.80b	3726.44a
'Jales'	54.18a	1859.61a	5166.46a	2126.26b
'Paulsen 1103'	44.86c	1250.23ab	1425.08b	3546.23a
C.V.(%)	4.43	22.85	25.36	18.95

*Means followed by the same letter in the columns do not differ among each other by the Tukey test at 5% probability.

TABLE 2- Chlorophyll relative index (CRI) in 'Thompson Seedless' grapevines at the phenological stages of full-bloom, berries pre-softening and dormency, grafted on rootstocks 'Harmony', 'SO4', 'Jales' and 'Paulsen 1103' , in a commercial area in the Vale do São Francisco, Juazeiro, BA, 2012.

	CRI	CRI	CRI
Rootstocks	Full bloom	Pre-softening	Dormency
'Harmony'	31.98ab	38.24a	35.08a
'SO4'	28.62c	35.22bc	33.48a
'Jales'	33.06a	37.12ab	35.32a
'Paulsen 1103'	31.04b	33.46c	34.90a
C.V.(%)	2.8	3.72	4.53

*Means followed by the same letter in the columns do not differ significantly from each other by the Tukey test, at %probability.

TABLE 3-Percentages of fertile buds (FB), vegetative buds (VB), dead buds (DB), dark buds (DB) (under magnifying glass) and real buds fertility (RBF) (in field) for 'Thompson Seedless' grafted on the rootstocks 'Harmony', 'SO4', 'Jales' e 'Paulsen 1103', at the comercial area in Vale do São Francisco. Juazeiro, BA, 2012.

Rootstocks	FB (%)	VB (%)	DB (%)	DB (%)	RBF (%)
'Harmony'	36.6a	42.8a	16.0a	4.4b	31.6ab
'SO4'	39.4a	43.8a	10.4a	6.0ab	38.8a
'Jales'	23.6b	53.6a	13.8a	9.4a	20.2c
'Paulsen 1103'	31.6ab	50.8a	9.4a	8.2ab	27.0bc
C.V(%)	16.5	16.1	33.1	35.4	14.4

*Means followed by the same letter in the columns do not differ significantly from each other by the Tukey test, at 5% probability.

TABLE 4 - Length (cm), width (cm) and cluster fresh mass (g) of 'Thompson Seedless' grafted on rootstocks 'Harmony', 'SO4', 'Jales' and 'Paulsen 1103', in the commercial area in the Vale of São Francisco. Juazeiro, BA, 2012.

Rootstocks	Cluster length	Cluster width	Cluster fresh mass
'Harmony'	21.76a	14.04ab	774.02a
'SO4'	20.54ab	13.70ab	588.76b
'Jales'	18.68bc	14.64a	627.76b
'Paulsen 1103'	17.26c	11.00b	558.78b
C.V.(%)	5.26	13.24	9.86

*Means followed by the same letter in the columns do not differ significantly from each other by the Tukey test, at 5% probability.

TABLE 5- Berry length (BL), berry diameter (BD), berry fresh mass (BFM), berry volume (BV) of'Thompson Seedless' grapevine grafted on rootstocks 'Harmony', 'SO4', 'Jales' e 'Paulsen 1103', in the commercial area of the Vale do São Francisco. Juazeiro, BA, 2012.

Rootstocks	BL (mm)	BD (mm)	BFM (g)	BV (mL)
'Harmony'	33.26a	19.38ab	7.70a	7.47a
'SO4'	30.60b	18.74b	6.60ab	6.35b
'Jales'	29.26b	19.80a	6.80ab	6.65ab
'Paulsen 1103'	29.48b	19.01ab	6.30b	6.21b
C.V(%)	4.40	2.85	8.82	8.66

*Means followed by the same letter in the columns do not differ significantly from each other by the Tukey testa t 5% probability.

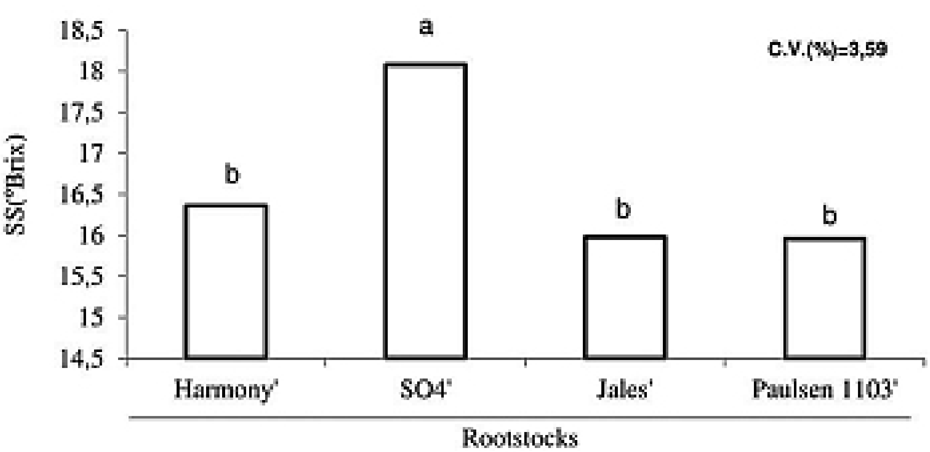

FIGURE 1- Soluble solids content (ºBrix) in 'Thompson Seedless' grafted on rootstocks 'Harmony', 'SO4', 'Jales' and 'Paulsen 1103' in the commercial area in the Vale do São Francisco. Juazeiro, BA, 2012.

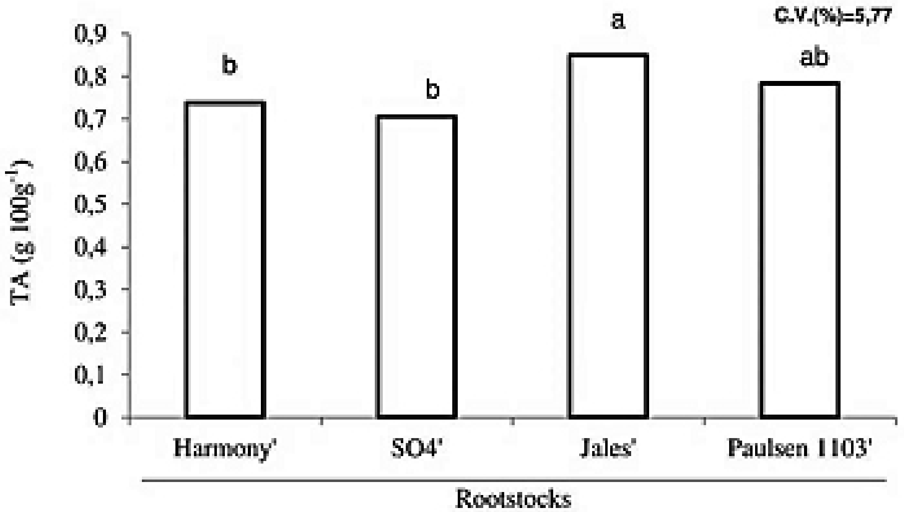

FIGURE 2- Titratable acidity (g tartaric acid / 100g of pulp) in the berries of ‘Thompson Seedless’ grafted on rootstocks ‘Harmony’, ‘SO4’, ‘Jales’ and ‘Paulsen 1103’ in commercial area in Vale do São Francisco Juazeiro, BA, 2012.

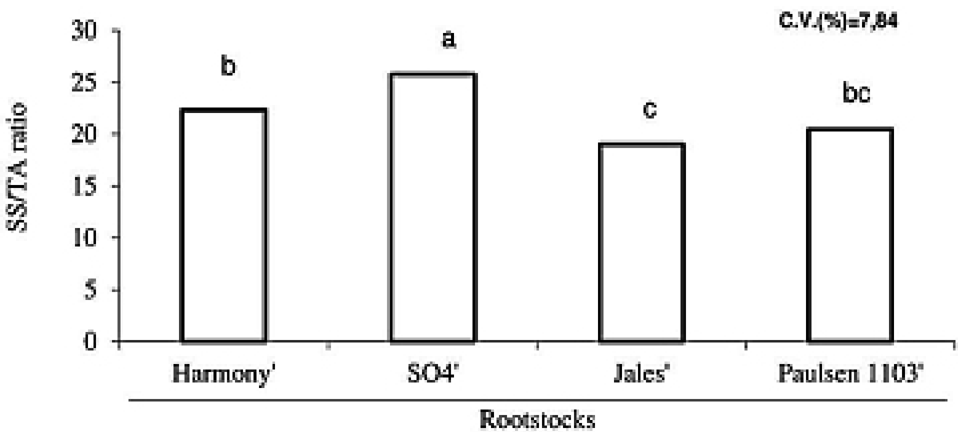

FIGURE 3- Soluble solids / titratable acidity ratio in the berries of ‘Thompson Seedless’ grafted on rootstocks ‘Harmony’, ‘SO4’, ‘Jales’ and ‘Paulsen 1103’ in commercial area in Vale do São Francisco. Juazeiro, BA, 2012.

CONCLUSION

It is possible to evaluate the nitrogen content of ‘Thompson Seedless’ vine plants with the use of chlorophyll meter and portable nitrate meters in the sap; there were differences in leaf nitrogen, nitrate in sap and CRI of ‘Thompson Seedless’ grapevine in relation to evaluated rootstocks, and rootstock ‘Jales’ presented higher N content in the leaves in flowering and higher concentration of nitrate in the sap, both in flowering and pre-softening of berries. When it was grafted on ‘Harmony’, the ‘Thompson Seedless’ grapevine expressed a higher fertility rate of buds and better potential for the development of clusters and berriesTable 1. Nitrogen content (N) in the leaf and nitrate (NO^-_3) in the sap of the ‘Thompson Seedless’ grapevine at the phenological stages of full bloom, pre-softening of berries and dormency on rootstocks ‘Harmony’, ‘SO4’, ‘Jales’ and ‘Paulsen 1103’, in a commercial area in the Vale do São Francisco .

REFERENCES

BILLONES-BAAIJENS, R.; JONES, E.E.; RIDGWAY, H.J.; JASPERS, M.V. Susceptibility of common rootstock and scion varieties of grapevines to Botryosphaeriaceae species. **Australasian Plant Pathology**, Collingwood, v.43, n.1, p.25-31, 2014.

BRIGHENTI, A.F.; RUFATO,L.; KRETZSCHMAR,A.A.; SCHLEMPER,C. Desempenho vitivinícola da Cabernet Sauvignon sobre diferentes porta-enxertos em região de altitude de Santa Catarina. **Revista Brasileira de Fruticultura**, Jaboticabal, v.33, n.1, p.96-102, 2011.

BRUNA, E.D.; BACK, A.J. Comportamento da cultivar Niágara rosada enxertada sobre diferentes porta-enxertos no sul de Santa Catarina, Brasil. **Revista Brasileira de Fruticultura**, Jaboticabal, v.34, n.5, p.924-933, 2015.

CSIKÁSZ-KRIZSICS, A.; DIÓFÁSI, L. Effects of rootstockson combinations on macroelements availability of the vines. **Journal Central European Agricultures**, Plovdiv, v.9, n.3, p.495-504, 2008.

GIOVANINNI, E. **Manual de viticultura**: série Tekne. Porto Alegre: Bookman, 2014. p.252.

IBGE – Instituto Brasileiro de Geografia e Estatística. Rio de Janeiro, 2015. Disponível em: <http://www.ibge.gov.br>. Acesso em: 05 nov. 2016.

JOGAIAH, S.; RAMTEKE, S.D.; SHARMA, J.; UPADHYAY, A.K. Moisture and salinity stress induced changes in biochemical constituents and water relations of different grape rootstock cultivars. **International Journal of Agronomy**, Maharashtra, p.1-8, 2014.

LEÃO, P.C.S.; BRANDÃO, E.O.; GONÇALVES, N.P.S. Produção e qualidade de uvas de mesa 'Sugraone' sobre diferentes porta-enxertos no Submédio do Vale do São Francisco. **Ciência rural**, Santa Maria, v.41, n.9, p.46-51, 2011.

LEÃO, E. L.L.; MOUTINHO, L.M.G. **Arranjo produtivo local da fruticultura irrigada do Vale do Submédio do São Francisco** - Pernambuco/ Bahia: fluxos comerciais e dinamismo local. 2014. Disponível em: http://www.coreconpe.org.br/iiienpecon/artigos/4enpecon2014.pdf.

MACHADO, R.; TECCHIO, M.A.; MOURA, M.F.; TEIXEIRA, L.A.J.; TERRA, M.M.; PIRES, E.J.P.; SILVA, D.S.; ROSA, S.M. Efeito do porta-enxerto no índice relativo de clorofila, nos teores de nitrato e de potássio na seiva do pecíolo da videira Niagara Rosada. In: CONGRESSO INTERINSTITUCIONAL DE INICIAÇÃO CIENTÍFICA, 4., 2010, Campinas. **Anais...**

MELO, P.S.F.; RIBEIRO, V.G. Porta-enxertos, citocininas, retardantes de crescimento e uracil Na fertilidade de gemas de videiras apirênicas. **Revista Caatinga**, Mossoró, v.25, n.1, p.80-85, 2012.

MIELE, A.; RIZZON, L.A.; GIOVANNINI, E. Efeito do porta-enxerto no teor de nutrientes em tecidos da videira 'Cabernet Sauvignon'. **Revista Brasileira de Fruticultura**, Jaboticabal, v.33, n.4, p.1141-1149, 2009.

MINOLTA. **Chlorophyll meter SPAD-502**: instruction manual. Osaka, 1989. 22p.

MUROLO, S.; ROMANAZZI, G. Effects of grapevine cultivar, rootstock and clone on esca disease. **Australasian Plant Pathology**, Clayton, v.43, n.2, p.215-221, 2014

ROCHA, M.G.; BASSOI, L. H.; SILVA, D.J. Atributos do solo, produção da videira, 'Syrah' irrigada e composição do mosto em função da adubação orgânica e nitrogenada. ***Revista Brasileira de Fruticultura***, Jaboticabal, v.37, n.1, p.220-229, 2015.

ROSA, A.M.; PESCADOR, R., SILVA, A.L.; BRIGHENTI, A.F.; BRUNETTO, G. Fertilidade e reservas de carbono e nitrogênio em gemas de ramos das viníferas 'Carbernet Sauvignon' e 'Nebbiolo'. **Revista Brasileira de Fruticultura**, Jaboticabal, v.36, n.3, p.576-585, 2014.

SANTOS, A.C.M.M.; KHON, R.A.G.; KHON, E.T.; MACIEL, S.M.; SOARES, T.M. Influência da declividade do terreno no vigor de *vittis vinifera* 'Petit Verdot' produzidas na região da campanha. **Revista da Jornada de Pós Graduação e Pesquisa**, Bagé, v.13, p.1-7, 2016.

SERRA, I.A.; STREVER, A.; MYBURGH, P.A.; DELOIRE, A. Review: the interaction between rootstocks and cultivars (Vitis vinifera L.) to enhance drought tolerance in grapevine. **Australian Journal of Grape and Wine Research**, Adelaide, v.20, n.1, p.1-14, 2014.

SOUZA, E.R.; LENK, F.L.; ONO, E.O.; RODRIGUES, J.D. Conteúdo de carboidratos em estacas de videiras do porta-enxerto cv. IAC 572. **Brazilian Journal of Applied Technology for Agricultural Science**, Guarapuava, v.8, n.2, p.7-15, 2015.

SOUZA, E.R.; RIBEIRO, V.G.; DANTAS, B.F.; LIMA FILHO, J.M.P. Variação de carboidratos em folhas da videira 'Itália' submetida a diferentes de níveis de desfolhas. **Revista Brasileira de Ciências Agrárias**. Recife, v.8, n.4, p.535-539, 2013.

SOUZA, E.R.; RIBEIRO, V.G.; PIONÓRIO, J.A.A. Percentagem de fertilidade gemas e teores carboidratos contidos em raízes, sarmentos e folhas da videira cultivar Itália. **Pesquisa Aplicada & Agrotecnologia**, Guarapuava, v.4, n.1, p.83-95, 2011.

SOUZA, I.A.; RIBEIRO, K.G.; ROCHA, W.W.; ARAÚJO, S.A.C.; PEREIRA, O.G.; CECON, P.R. Forage mass, chemical composition and leaf chlorophyll index of signal grass and organic matter in soil under increasing levels of nitrogen. **Semina**: **Ciências Agrárias**, Londrina, v.37, n.3, p.1505-1514, 2016.

TECCHIO, M.A.; PIRES, E.J.P.; TERRA, M.M.; MOURA, M.F. Produtividade e teores de nutrientes da videira Niágara Rosada em vinhedos nos municípios de Louveira e Jundiaí. **Bioscience Journal**, Uberlândia, v.23, n.1, p.48-58, 2007.

TSEGAY, D.; AMSALEM, D.; ALMEIDA, M.; CRANDLES, M. Responses of grapevine rootstocks to drought stress. **International Journal of Plant Physiology and Biochemistry**, Montpellier, v.6, n.1, p.1-6, 2014.

VILAR, P.F.I.; SOUZA, E.I.; SANTOS, L.S.; MARTINEZ, E.A.; RIBEIRO, V.G. Phytoregulators on bud fertility and cluster quality of 'Thompson Seedless' grapes grafted onto 'Ramsey' rootstock. **Revista Caatinga**, Mossoró, v.30, n.1, p.97-108, 2017.

VILLAR, L.; TERRA, M.M.; TECCHIO, M.A.; PIRES, E.J.P.; MACEDO, W.R. Efeito do ácido giberélico e citocininas sobre a qualidade da uva apirena BRS Clara. **Revista Brasileira de Viticultura e Enologia**, Bento Gonçalves, v.5, n.5, p.18-25, 2013.