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Effect of Using Basal Fertilizer 15-15-15 on Leaf Chlorophyll a Fluorescence, Plant Growth and Fruit Yield of Table Grapes Grown under the Mediterranean Climate Conditions of the Northeast of Morocco

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ABSTRACT

Plant nutrition presents one of the main concerns of table growers in Morocco. Since the increase of the prices of fertilizers, the optimization of the amount of nutrients elements is important. Crop deficiency in terms of Nitrogen (N), Phosphorus (P) and Potassium (K) was demonstrated to decrease growth and productivity of plants. The objective of this research was to investigate the effect of adding Basal N-P-K Fertilizer (15-15-15) to soil on some physiological parameters of table grapes, such as chlorophyll fluorescence, plant growth and fruit yield. Trials were conducted northeast of Morocco and under Mediterranean climate conditions on a production of 8-year-old table grapes (v. Regal). The planting density was 2000 plants/ha. In a field of 10 ha of commercial production, a plot of twenty-four trees were selected for each treatment (control (C) and treated (Tr) plants with basal fertilizer). A basal fertilizer (15-15-15) was applied in the beginning of the vegetative growth stage, at 5 cm above to the root system. An amount of 150 g/tree was applied. A conventional fertilization program was used by the grower in both control and treated plots, except for the prototype treatment plots where the basal fertilizer was only applied. No significant effect of the treatment on plant growth and fruit yield was noted. Moreover, no significant difference was recorded on leaves relative water content (RWC), chlorophyll content (LCC), and chlorophyll fluorescence parameters such as: F_0, Fm, F_v/F_m, V_i V_j, ABS/RC, DI_0/RC, TR_0/RC, ET_0/RC and RE_0/RC.

Keywords: grapes, light reaction, nutrition, productivity, photosynthesis, photosystem, stress index and *Vitis vinifera*.

INTRODUCTION

Table grapes (*Vitis vinefera*) present an important crop production in Morocco. The area of the plantations is 49 000 ha, where 77% is for table grapes and 23% for wine production (Agrimaroc, 2021). The most used fertilization methods are surface or basal fertilizers, foliar fertilization, and fertigation. The Nitrogen (N), Phosphorus (P) and Potassium (K) requirements of the grapes differ in terms of units 100–120 kg/ha, 80–120 kg/ha and 120–180 kg/ha, respectively. Nitrogen promotes plant growth and photosynthesis (Mu and Chen, 2021). Phosphorus enhances root growth and development, as well as plays a vital role for nutrient transport and for the metabolism of carbohydrates (Iqbal et al., 2022; Kim and Li, 2016; Samri et al., 2021). Potassium is considered as an element that increases production and improves fruit quality. It is also an essential element for the color and taste of the fruit (Harhash and Abdel-Nasser 2010; Khan et al., 2022). It involves respiration; assimilation of chlorophyll transport and storage of carbohydrates (Hou et al., 2019).

Many farmers apply basal fertilizers based on granular slow and balanced release N-P-K fertilizers, early in the growing season, so plants have time to absorb these nutrients gradually. These granules stay in the ground and slowly release into the soil to provide fractional amounts

in terms of fertilizer. However, the type and amount of fertilizer needed in a grape production depends on many different factors, such as type of soil and its compounds, plant age, phenological stage, crop management, environmental conditions, and variety.

It has been shown that nutrient deficiency in grapes leads to reduced growth, yield as well as quality of the produce (Ali et al., 2021). Table grapes require much more nitrogen, especially during vegetative and veraison stages (Ferrara et al., 2018). In part, it has been shown that nitrogen deficiency decreases vegetative growth, causing excessive generative growth and thus, decreasing the crop production (Kacar, 1997). Conversely, excessive nitrogen can lead to excessive vegetative growth and reduction in yield as well as decrease the fruit quality (Chang and Kliewer, 1991). The selection of accurate nitrogen doses is an important issue to maintain a balance between the vegetative and reproductive growth of grapes (Carranca et al., 2018). In other part, phosphorus is an essential nutrient for plant growth and development, as well as an important limiting nutrient for the crops (Bindraban et al., 2020). Phosphorus plays a vital role to stimulate root development, such as the formation of seminal and hair roots as well as increased stalk, stem strength and resistance to plant diseases (Havlin et al., 2005). It has also been found that phosphorus is found in soil naturally or can be applied as fertilizers but its availability is affected by many factors, such as clay soil content, calcium carbonate, pH, moisture content, etc. (Samadi, 2006).

The Potassium (K) available in the soil can be taken up and transported to the leaves and berries (Ciotta et al., 2022). The amount of K in berries can represent more than 50% of K found in other plants oranges (Mpelasoka et al., 2003). The role played by K in grape is associated with enzymatic synthesis and activation reactions, which contribute to enhancement of berry ripening, sugar concentration and cell turgor maintenance (Gill et al. 2012; Karimi, 2017). Several research works reported that potassium fertilization increased the yield of grapes. Potassium fertilization improved fruit quality and sugar content. Furthermore, K plays a key role in solute transportation, partitioning of assimilates, and in the synthesis of several polyphenols that account for grape color and aroma (Ramos and Romero, 2016).

In other part, chlorophyll a fluorescence measurement present a suitable way to evaluate photosynthesis efficiency and stress index of the crops (Govindje, 1995; Kumar et al., 2020; Strasser et al., 2024; Schreiber et al., 1987; Schreiber, 2004;). This method can provide data on the ability of plants to respond and tolerate environmental stresses (Maxwell and Johnson, 2000). The relationship between chlorophyll a fluorescence and nutrient status was evaluated in several studies on different species (Strand and Lundmark, 1995). specific stress index or chlorophyll a fluorescence, such as F_v/F_m, F_0, Tf_m V_i, V_j, ABS, ET_0, DI_0, TR_0, RE_0 and PI. Chlorophyll fluorescence usually indicates the transfer of electrons during the light phase of photosynthesis from the excitation of chlorophyll by light energy to the transfer of electrons for the dark phase. Usually, stress reduces variable fluorescence (F_v), initiative fluorescence (F_0) and quantum yield (F_v, F_m). The ratio Fv/Fm varies between 0.75 and 0.85 in non-stressed plants and it is a good indicator for stress level status. Moreover, the PI presents the performance index of the leaf, and it is calculated from modeling of sixty parameters of leaf fluorescence. The more plants are stressed, the PI decreases (Živčák et al., 2008). The objective of this study was to investigate the effect of applying a basal fertilizer comprising 15% nitrogen, 15% phosphorus and 15% potassium on leaf chlorophyll a fluorescence, plant growth and fruit yield of table grapes grown under the Mediterranean climate conditions of the northeast of Morocco.

MATERIALS AND METHODS

Experimental site

This study was carried out in the region of "El GARET" (34°59'51.0"N 3°03'50.9"W), northeast of Morocco, on a production of 8-year-old table grapes (Figure 1a). This region is characterized by Mediterranean climate, with an average precipitation rate of 250–300 mm/year. The planting density was 2000 plants/ha. Each row was spaced at 3 m and the distance between two plants of the same row was 1.5 m. The "Regal" variety was used during this experiment. A dripper of 4 L/h was used for irrigation. The crops have been managed according to the good practices of the commercial production of table grapes in Morocco, regarding fertilization, irrigation, pesticides, etc.

Figure 1. Field experiments of table grapes, Cv. Regal (a); Basal fertilizer was applied on April 7th, 2022, at 5 cm under the ground and just above to the root system (b-c) and Measurements of leaf chlorophyll content (LCC) using the SPAD meter (d)

Treatments

Twenty-four trees were selected for each treatment (control (C) and plants treated (Tr) with basal fertilizer). A basal fertilizer (15-15-15) was applied on April 7th, 2022, at 5 cm under the ground and just above to the root system (Figure 1b-c). An amount of 150 g/tree was applied for treated plants. A conventional fertilization program was used by the grower (Table 1) in both control and treated plots, except for the prototype treatment plots where the basal fertilizer 15-15-15 was applied.

Measurements

Plant growth

Several parameters of plant growth were measured every 2 weeks from April until June. Measurements were recorded on 24 plants for each treatment (without (C) and with (Tr) fertilizer) and were realized on April 27th, May 11th, 25th, June 8th, 23rd and July 4th, 21st 2022. The following parameters were recorded: plant height and number of sticks. One stick was selected for each tree in order to measure its length, number of nodes, number of fruit cluster. Then, the fifth shoot from the apex of the stick was selected in order to measure its length and also the number of fruit cluster per shoot.

Relative water content (RWC)

It presents one of the most appropriate measures of plant water status in terms of the physiological consequence of cellular water deficit. Twelve samples were taken for two days (June 8th and September 21st, 2022), early in the morning, from each treatment and each sample represents a different plant. Each sample contains 5 leaves taken randomly from plants of the same block giving one sample. Top-most fully expanded leaves were sampled; the fifth leaf from the apex of the fifth selected shoot of the selected stick was taken for the growth measurements. Leaf square disc (2 × 2 cm) was used to cut the leaves, to obtain a total of about 4 cm^2/sample. The sampling proceeded quickly and the fresh sample was weighted in the field (W). Always, immediately

Table 1. The fertilizers program applied by the grower in the both control and treated plots; except for the prototype treatment plots where the basal fertilizer 15-15-15 was applied

Date	Fertilizer	Dose/ha	Date	Fertilizer	Dose/ha
8/04	12-61-0 Magnesium sulfate (16%)	10 kg 6 kg	1/06	12-61-0 Nitrogen (30%) Magnesium sulfate (16%)	8 kg 4 l 6 kg
10/04	Sulfric acid	4 l	5/06	Calcium nitrate (15-0-0-26) Nitric acid	8 kg 2 l
14/04	Root Bio-stimulant	5 l	8/06	Amino acid (42%) and Total Nitrogen (14%)	10 l
17/04	28-14-14 Microtex LQ	10 kg 2.5 l	12/06	28-14-14 8-8-36	4 kg 6 kg
20/04	Nitrogen (30%)	7 l	15/06	12-61-0 Nitrogen (30%) Magnesium sulfate (16%)	8 kg 4 l 6 kg
24/04	Calcium nitarte (15-0-0-26) Nitric acid	8 kg 2 l	19/06	Calcium nitarte (15-0-0-26) Nitric acid	8 kg 2 l
27/04	28-14-14 Magnesium sulfate (16%)	10 kg 6 kg	22/06	Amino acid (42%) and Total Nitrogen (14%)	10 l
30/04	Organic acid (41%) and Fluvic acid (35%)	10 l	25/06	28-14-14 8-8-36	8 kg 3 kg
4/05	Root Bio-stimulant	5 l	28/06	Sulfric acid	2 l
8/05	12-61-0 Magnesium sulfate (16%)	8 kg 6 kg	01/07	8-8-36	10 kg
18/4	Organic acid (45%), Fluvic acid (25%), Potassium (3%)	10 l	05/07	Amino acid (42%) and Total Nitrogen (14%)	10 l
21/4	Zinc sulfate (34%)	7 kg	08/07	13-5-40	8 kg
2/5	28-14-14 Micronutrient mixture	10 kg 2.5 kg	12/07	Calcium nitarte (15-0-0-26) Nitric acid	8 kg 2 l
28/05	Organic matter (16%) and K20 (7%)	4 l	1/06	12-61-0 Nitrogen (30%) Magnesium sulfate (16%)	8 kg 4 l 6 kg

in the field, samples were hydrated in distilled water to full turgidity and then moved to the laboratory for 48 h under normal room light and temperature. After hydration, the samples were taken out of water and were well dried of any surface moisture quickly and lightly with filter/tissue paper and immediately weighed to obtain fully turgid weight (TW). Samples were then placed in a steaming room at 80°C for 48 h and weighed to determine dry weight (DW). All weighings were done to the nearest mg. The formula of the calculation of RWC is presented as following (Eq. 1):

$$RWC\ (\%) = [(W\text{-}DW) / (TW\text{-}DW)] \times 100 \quad (1)$$

where: W – sample fresh weight, TW – sample turgid weight, DW – sample dry weight.

Leaf chlorophyll content (LCC)

An SPAD meter (SPAD-502Plus, Konica-Minolta, Langenhagen, Germany) was used for LCC records which present an indicator of leaf photosynthetic capacity and for the understanding of plant physiological status. SPAD meters are routinely used, as a non-destructive instrumentation to provide an instantaneous estimation of leaf chlorophyll content in situ (Figure 1d). Growth measurements were made on the fifth leaf from the apex of the fifth selected shoot of the selected stick. Measurements were recorded on 10 plants for each treatment, during two period of the day and two times during experiment (June 7th and July 13th). Each measure presents the mean of three records per each leaf sample. The SPAD was calibrated for each measure.

Chlorophyll a fluorescence and stress index

HPEA (Handey PEA, Hansatech, UK) was used for chlorophyll fluorescence records. Measurements were made on a hot and sunny day, (August 22nd, 2022) (T_{max}=37°C, T_{min}=18°C, RH_{max}=78%, RH_{min}=14%) from 12:30 until 13:15. Measurements were taken on the fifth leaf from the apex of the fifth selected shoot of the selected stick. For the stress fluorescence measurements, leaves were adapted to the dark for 30 min using a clip. Then, a light flash of 3000 µmol/m^2/s (650 nm) was applied for 1 s (gain = x1) on the leaf adapted to darkness for 30 min. The

measurements were taken on 10 plants for each treatment. The measured parameters indicate the transfer of electrons during the light phase of photosynthesis from the excitation of chlorophyll by light energy to the transfer of electrons for the dark phase and they are good indicators of plant stress (Strasser and Tsimilli-Michael, 2004). Many chlorophyll fluorescence parameters were measured, and each has a specific physiological indication (Table 2).

Fruit yield

At the end of the experiment; October 23rd, 2022, the number of clusters was measured on 24 plants for each treatment. Also, the fruit cluster weight per plant was recorded on 8 plants for each treatment.

Statistical analysis

Statistical analyses were performed using IBM SPSS version 21-Software. For each parameter evaluated, replicates were taken for both treatments. Means with standard deviations were used to determine the differences between treatments. The mean values obtained for the two treatments were compared by using *Test of Student* and the significance level was $P < 0.05$.

RESULTS AND DISCUSSION

Regarding the plant growth, no significant differences were recorded between control and the fertilizer treatment (Table 3). The initial measurements showed that plant height, number of sticks and length of selected stick and number of nodes per selected stick was the same for both treatments. These initial measurements were taken 20 days after the application of the fertilizer 15-15-15 (April 7th). However, 84 days later (July 21st), no significant effect of the fertilizer treatment was recorded on the number of leaves and clusters on the selected shoot, length of the shoot and finally on the number of clusters of the selected sticks. Thus, this obtained data could be

Table 2. Physiological signification of each chlorophyll fluorescence parameters recorded on July 13th, 2022. HPEA was used for chlorophyll fluorescence measurements

Parameters	Physiological signification
F_0	It represents the emission by molecules of chlorophyll a excited in the structure of the antennas of photosystem II. F0 value is observed when the first stable electron acceptor of photosystem II called Qa is fully oxidized. It requires complete adaptation to the dark. F_0 occurs at time base 0.
F_1	Chlorophyll fluorescence at time 50 µs.
F_2	Chlorophyll fluorescence at time 100 µs.
F_3	Chlorophyll fluorescence at time 300 µs (K step).
F_4	Chlorophyll fluorescence at time 2000 µs (J step).
F_5	Chlorophyll fluorescence at time 3000 µs (I step).
F_m	Maximum fluorescence value obtained for a continuous light intensity. This parameter can only be called maximum fluorescence if the light intensity is completely saturated for the installation and the electron acceptor *Qa* is completely reduced.
F_v/F_m	This parameter widely used to indicate the maximum quantum efficiency of photosystem II. This parameter is considered to be a sensitive indication of the photosynthetic performance of plants with healthy samples generally reaching a maximum F_v/F_m value of around 0.85. Lower values than 0.85 are observed on exposed sample to some type of biotic or abiotic stressor which reduced the photochemical energy quenching capacity in the PSII.
V_i	Relative variable fluorescence at 30ms: $V_i = (F_{30ms} - F_0) / (F_m - F_0)$ (Equation 2)
V_j	Relative variable fluorescence at 3ms. $V_j = (F_{2ms} - F_0) / (F_m - F_0)$ (Equation 3)
ABS/RC	Light absorption flux, for PSII antenna chlorophylls, by reaction center (RC).
DI_0/RC	Dissipation energy flow per PSII reaction center.
TR_0/R	Specific trapping flux at time zero.
ET_0/RC	Maximum electron transport flux per PSII reaction center.
RE_0/RC	Electron acceptors on the PSI acceptor side by PSII reaction center.
PI_{total}	Leaf performance index.

Table 3. Plant growth parameters measured on April 27th (Initial measurements) and on July 21st (final growth measurements) for the control and prototype plants without and with basal fertilizer 15-15-15

Parameter	Control (without)	Prototype (+15-15-15)	Significance (α=0,05)
Initial measurements (April 27th, 2022)			
Plant height (cm)	125 ±8	128 ±7	n.s
Number of sticks/plants	5 ±1	5 ±1	n.s
Length of selected stick cm)	86 ±14	92 ±20	n.s
Number of nodes per selected stick	9 ±2	10 ±3	n.s
Final measurements (July 21st, 2022)			
Number of clusters per selected shoot	2 ±1	2 ±1	n.s
Length of selected shoot* per selected stick (cm)	73 ±38	79 ±26	n.s
Number of clusters per selected shoot*	13 ±5	15 ±5	n.s
Number of leaves per selected shoot*(**)	10 ±4	11 ±3	n.s

Note: ** number of leaves per selected shoot recorded on May 25th, 2022. Data are mean of 24 repetitions ± standard deviation. n.s=not significant (α=0.05).

explained, in part, by the fact that the fertilizer did not affect plant growth during the first year and 100 days after treatments could be not enough to change the crop growth (Garzón et al., 2011; Liu et al., 2021). Also, it could be explained, in another part, that the solid fertilizer in soil takes more time to be available for the uptake by crops (Zhou et al., 2022). Moreover, the soil resources in terms of nutrients, and the fertilizer uptake by plants (Table 1) was enough for growth and there was no need for more fertilizer.

For the RWC of the fifth leaf taken from the apex, no significant differences between treatments were recorded (Table 4). On June 8th, RWC values were 18.8% and 18.0% for the control and the fertilizer treatment, respectively. After 103 days (September 21st), it seems that the RWC was increased but not affected by treatment; the obtained values were 27.2% (control) and 28.0% (15-15-15). This means that the water status of this selected fifth leaf did not change with the fertilizer treatment. Previous research work demonstrated that RWC and leaf water content could be changed or not when applying fertilizer based on nitrogen, phosphorus, and potassium (Mamunur Rashid et al., 2016). This has also been reported by Wenyi et al. (2011) who showed that high concentration of N, P and K could affect the water content in the leaves. Conversely, the results of these studies did not show any difference in water content of the leaves and even the treatment of 15-15-15 was applied.

Regarding the LCC (Table 4) of the fifth leaf taken from the apex of the shoot, no significant differences were recorded between treatments for both measurements taken on June 7th and July 13th. Previous works showed difference in leaf chlorophyll content when N-P-K was applied (Fiorentini et al., 2019; Shaobing et al. 1999; Sidi et al., 2022). For the Chlorophyll a fluorescence measurement taken on the fifth leaf, from the apex of the plant, no significant differences were recorded between treatments for the control and the fertilizer treatment regarding the parameters F_0, Fm, F_v/F_m, V_i V_j and values were respectively 595, 2638, 0.7, 0.78 and 0,54 for the control and 565, 2403, 0.75, 0.78 and 0.63, for the treatment with fertilizer (Table 5).

Table 4. Leaf relative water content (RWC) and leaf chlorophyll content (LCC) measured twice during experiments for the control and prototype plants without and with basal fertilizer 15-15-15.

Parameter	Control (without)	Prototype (+15-15-15)	Significance (α = 0.05)
RWC (June 8th, 2022) (%)	18.8 ±4.7	18.0 ±6.8	n.s
RWC (September 21st, 2022) (%)	27.2 ±5.3	28.0 ±5.5	n.s
LCC (June 7th, 2022)	35.5 ±5.4	33.2 ±6.4	n.s
LCC (July 13th, 2022)	43.9 ±3.0	42.0 ±5.4	n.s

Note: data are mean of 7 (RWC) and 24 repetitions (LCC) ± standard deviation. n.s = not significant (α = 0.05)

Those parameters indicate, in part, that the stress status was the same for the control and the treated plants even air temperature was very high when the measurements were taken (37°C). As indicated in previous work, the ratio of F_v/F_m is between 0.75 to 0.85 for non-stressed crops, and with lowered values indicating plant stress (Kitajima and Butler, 1975; Maxwell and Johnson, 2000). Moreover, previous works showed that application of fertilizer based on N, P, K could enhance plant tolerance for high temperature stress, but the responses could be different according to many factors, such as: type of the crops, varieties, microclimate conditions, soil properties, nutrition status, etc. Regarding the ratios ABS/RC, DI_0/RC, TR_0/RC, ET_0/RC, RE_0/RC, they were not significantly affected by the fertilizer treatment and values were 2.35, 0.57, 1.80, 0.78 and 0.39, respectively, for the control and 2.61, 0.58, 1.88, 0.75 and 0.42 for the plants with the N-P-K fertilizer. Those results indicate that the reaction center (RC) status was the same for the control and for the treated plants and the number of electrons intercepted by the reaction center (ABS), dissipated as heat (DI_0), Maximum electron transport flux per PSII reaction center (ET_0) and Electron acceptors on the PSI acceptor side by PSII reaction center (RE_0) was the same. This could mean that the photosynthesis machinery and the electron transfer chain between the PSII and PSI did not change, even if fertilizer was added and even under stress air temperature conditions (Song et al., 2014). In addition, the performance index of the plant was the same for both treatment and value was 1.37. Finally, the OJIP curves (Figure 2) showed that the fluorescence according to time of application of the saturated flashlight (3000 µmol/m/s) during 1 s (or 1000 000 us). The fluorescence was enhanced by the same rate for the control and prototype leaves from time 50 µs (time corresponding for F) until 3000 µs (or time corresponding for F5). All those indicators endorse the idea that plants' stress status was not affected by the fertilizer treatment during this typical day with clear sky conditions and at midday when air temperature was very high. Previous research mentioned that plants' stress status could be changed instantly and this of course according to many edaphic and physiological factors (Bita and Gerats, 2013; Jerry et al., 2015; Niveola et al., 2017; Wariach et al., 2012).

For the fruit yield, cluster weight was slightly decreased for plants with fertilizer treatment, but this was not significant. The number of clusters was 74 clusters per plant for the control and 68 clusters/ plant for the treated plants. Also, the cluster weight did change, and values were 21 kg/ plant for both treatments (Table 6). These results confirm that the fertilizer application did not change the fruit yield as was suspected (Arora and Manav, 2012). In this case the fertilizer 15-15-15 was not enough to increase the yield of plants and the crops might achieve their need on nitrogen, phosphorus, and potassium without need for the supplement of 15-15-15. Previous studies showed that fertilizer N, P, K could increase yield and productivity of plants (Boyhan et al., 2023; Hong et al., 2022; Sharma et al., 2022; Singh, 2022). This effect of fertilizer on yield could always depend on many factors, such as type of the crop, plant age, plant variety, microclimate conditions, soil properties, etc.

Table 5. Parameters of leaf chlorophyll fluorescence and stress index measured on August 22nd, 2022 (at mid-day) for the control and prototype plants without and with basal fertilizer 15-15-15

Fluorescence parameters	Control (without)	Prototype (+15-15-15)	Significance (α = 0.05)
F_0	596 ±49	565 ±41	n.s
F_m	2638 ±495	2403 ±299	n.s
F_v/F_m	0.77 ±0.04	0.75 ±0.02	n.s
V_i	0.78 ±0.04	0.78 ±0.03	n.s
V_j	0.54 ±0.12	0.63 ±0.11	n.s
ABS/RC	2.35 ±0.24	2.61 ±0.53	n.s
DI_0/RC	0.57 ±0.12	0.58 ±0.12	n.s
TR_0/RC	1.80 ±0.13	1.88 ±0.14	n.s
ET_0/RC	0.78 ±0.14	0.75 ±0.16	n.s
RE_0/RC	0.39 ±0.07	0.42 ±0.06	n.s
PI_{total}	1.37 ±0.54	1.37 ±0.56	n.s

Note: data are mean of 10 repetitions ± standard deviation. n.s = not significant (α=0.05)

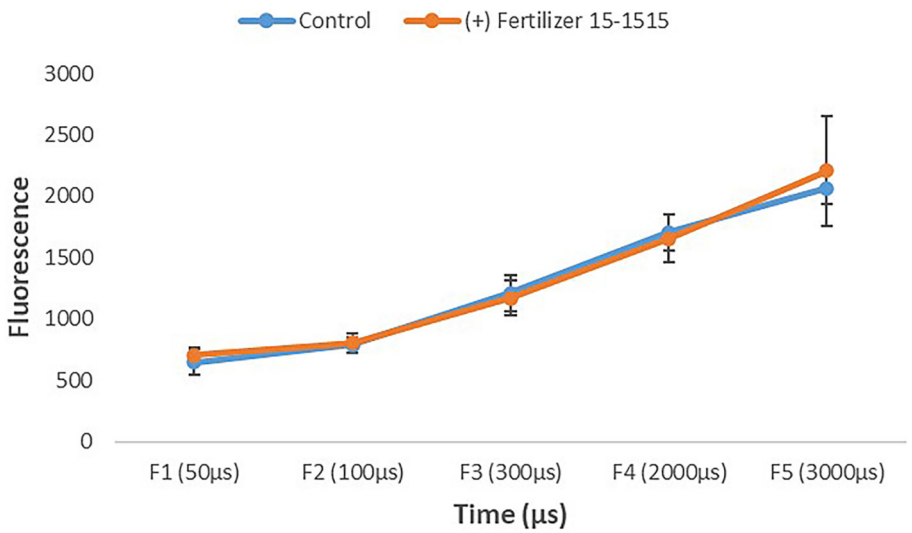

Figure 2. OJIP curves of the control and prototype plants without and with basal fertilizer 15-15-15, respectively. Data are mean of 10 repetitions ± standard deviation

Table 6. Plant yield of the control and prototype plants without and with basal fertilizer 15-15-15, respectively

Parameter	Control (without)	Prototype (+15-15-15)	Significance (α = 0.05)
Clusters number per plant	74 ±15	68 ±18	n.s
Clusters weight (kg)/plant	21 ±6	21 ±4	n.s

Note: data are mean of 8 (clusters weight) and 24 repetitions (cluster number) ± standard deviation. n.s = not significant (α = 0.05).

CONCLUSIONS

This research work investigated the effect using the basal fertilizer 15-15-15 on leaf chlorophyll a fluorescence, plant growth and fruit yield of table grapes grown northeast of Morocco. Results showed that there were no significant differences between control plants and the prototype plants provided with the basal N-P-K fertilizer, for growth, yield, and fluorescence parameters. Further parameters will be needed for measurements, in the future field trials, such as mineral content in soil, leaves, roots and fruits and sticks to quantify the N, P, K content and understand wherefore the 15-15-15 did not affect plant growth and yield.

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