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Rendimento e qualidade do fruto de melão em função de doses e épocas de aplicação de bioestimulante

Melon fruit yield and quality as a function of doses and times of biostimulant application

Rendimiento y calidad del fruto del melón en función de las dosis y tiempos de aplicación del bioestimulante

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Resumo

O objetivo deste estudo foi avaliar a produtividade e a qualidade dos frutos de melão em função da dose e do tempo de aplicação de bioestimulante nas condições do semiárido paraibano. O experimento foi realizado na Universidade Federal de Campina Grande, campus de Pombal - PB, Brasil, em delineamento de blocos casualizados em esquema de parcelas subdivididas 4 x 5, com doses de bioestimulante (0; 0,5; 1,0; 1,5 e 2,0 L ha^{-1}) e na subparcela dos tempos de aplicação do bioestimulante (15; 20; 25 e 30 dias antes da colheita - DAC), em quatro repetições. Características relacionadas à produção e qualidade dos frutos foram avaliadas. Não foi observada a interação dos fatores dose e tempo de aplicação do bioestimulante em nenhuma das características avaliadas. Assim, os maiores valores estimados de número de frutos por planta, massa de frutos e produção total de melão foram obtidos com a aplicação de doses variando de 0,9 a 1,5 L ha^{-1} e nos momentos de aplicação variou de 22,5 a 23,6 DAC. O teor de sólidos solúveis aumentou 5,5% quando se utilizou a dose bioestimulante de 2,0 L ha^{-1} e 4,4% quando o produto foi aplicado 15 dias antes da colheita.

Palavras-chave: *Cucumis melo* L.; Crescimento; Produtividade; Regulador de crescimento.

Abstract

The objective of this study was to evaluate the productivity and quality of melon fruits as a function of the dose and time of application of biostimulant in the conditions of the semi-arid region of Paraíba. The experiment was carried out at the Federal University of Campina Grande, campus of Pombal - PB, Brazil, in a randomized block design in a 4 x 5 split plot scheme, with doses of biostimulant (0; 0.5; 1.0; 1, 5 and 2.0 L ha^{-1}) and in the subset of the biostimulant application times (15; 20; 25 and 30 days before harvest - DAC), in four replications. Characteristics related to fruit production and quality were evaluated. There was no interaction between the factors of dose and application time of the biostimulant in any of the evaluated characteristics. Thus, the highest estimated values of number of fruits per plant, fruit mass and total melon production were obtained with the application of doses ranging from 0.9 to 1.5 L ha^{-1} and at the time of application it varied from 22,5 to 23.6 DAC. The content of soluble solids increased 5.5% when the biostimulant dose of 2.0 L ha^{-1} was used and 4.4% when the product was applied 15 days before harvest.

Keywords: *Cucumis melo* L.; Growth; Yield; Growth regulator.

Resumen

El objetivo de este estudio fue evaluar la productividad y la calidad de los frutos de melón en función de la dosis y el tiempo de aplicación del bioestimulante en las condiciones de la región semiárida de Paraíba. El experimento se llevó a cabo en la Universidad Federal de Campina Grande, campus de Pombal - PB, Brasil, en un diseño de bloques aleatorizado en un esquema de parcelas divididas de 4 x 5, con dosis de bioestimulante (0; 0.5; 1.0; 1, 5 y 2.0 L ha^{-1}) y en el subconjunto de los tiempos de aplicación de bioestimulantes (15; 20; 25 y 30 días antes de la cosecha - DAC), en cuatro repeticiones. Se evaluaron las características relacionadas con la producción y calidad de la fruta. No hubo interacción entre los factores de dosis y el tiempo de aplicación del bioestimulante en ninguna de las características evaluadas. Por lo tanto, los valores estimados más altos de número de frutas por planta, masa de fruta y producción total de melón se obtuvieron con la aplicación de dosis que varían de 0.9 a 1.5 L ha^{-1} y en el momento de la aplicación varió de 22, 5 a 23,6 DAC. El contenido de sólidos solubles aumentó 5.5% cuando se usó la dosis bioestimulante de 2.0 L ha^{-1} y 4.4% cuando el producto se aplicó 15 días antes de la cosecha.

Palabras clave: *Cucumis melo* L.; Crecimiento; Rendimiento; Regulador del crecimiento.

1. Introduction

Melon (*Cucumis melo* L.) is a plant whose fruits have high economic and social expression in Brazil, especially for the northeast region which concentrates approximately 95% of national production (IBGE, 2019) and which has favorable conditions for its cultivation, such as high levels of radiation and temperature and low rainfall and relative humidity together with no fruit fly.

In 2018, this culture produced 540,229 tons of fresh fruits, of which 342,629 tons were destined to the domestic market and 197,600 tons in level of fresh fruit exports in Brazil; the main producer is the state of Rio Grande do Norte, with more than 50% of production destined for the Netherlands, the United Kingdom and Spain (Beling, 2018).

In the state of Paraíba, favorable soil and climate conditions for melon growth and development are favorable, but there has been a low production and planted area, mainly due to the little diffusion and use of appropriate technology adopted by producers, which leads to the lack stimulation, low productivity and fruit quality. This fact has led to the need to import fruits from other states to supply domestic demand, especially from Rio Grande do Norte, Ceará and Pernambuco.

The high productivity and the quality of the fruits are closely linked to the management applied in the cultivation of the crop, although, Halpern et al., (2015) show that the use of fertilizers in modern agriculture is highly inefficient; much of the applied fertilizer is released into the environment, causing environmental degradation and a way to reverse these aspects, and promoting a greater absorption of these nutrients by plants is through the use of biostimulants that are natural or synthetic substances that can be applied to seeds, plants and soil (via irrigation or leaf spray systems). However, it is known that the effect of these products on plants can be influenced by genetic and environmental factors, because they cause changes in vital and structural processes, in order to increase productivity and quality of crops (Dourado Neto et al., 2014).

Biostimulants are substances of organic origin that contain, in addition to plant regulators, other substances that indirectly promote plant growth, such as carbohydrates and amino acids (Galindo et al., 2019). In this sense, the use of these substances is one of the most promising technologies to increase crop productivity and fruit quality. Because these are substances, found on the market, composed of mixtures based on hormones, micronutrients, amino acids and vitamins, which have already been tested in several cultures, including soy (Albrecht et al., 2012), corn and beans (Dourado Neto et al., 2014), in lettuce (Izidório et al., 2015), tomato (Tavares et al., 2015), melon (Vendruscolo et al., 2017), among others.

Despite the considerable amount of studies on the application of biostimulants, information on the use of these products on fruits and, consequently, on their effect on their development is scarce. Therefore, it is necessary to know the appropriate dose and the ideal time of application of the biostimulant that increases the plant growth with positive effects on the productivity and quality of melon fruits.

The objective of this research was to evaluate the production and quality of melon fruits as a function of dose and time of application of biostimulant under conditions of Pombal – PB, Brazil.

2. Methodology

The experiment was conducted from December 2016 to February 2017 at the Federal University of Campina Grande (UFCG), Center for Agro-Food Science and Technology (CCTA), Pombal Campus – PB, Brazil. The soil of the experimental area is Fluvic Neossol type (EMBRAPA, 2008). During the experimental period, climatic variables related to temperature and air moisture in the area were recorded using a HT – 210 digital termohygrometer.

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The experiment consisted of a 4 x 5 split plot design, with four replications. The plot consisted of five doses of Crop Set® biostimulant (0,0; 0.5; 1.0; 1.5; 2.0 L ha^{-1}) with doses (0.0 L ha^{-1}) not applied nothing being used only as a witness and in the four-time subplot of application of the biostimulant by pulverizer the fruits with a 20 L. backpack sprayer (30; 25; 20 and 15 days before harvest – DAC). The commercial product Crop Set® (Improcrop-Kentucky – USA) is a plant biostimulant that consists of agave (Yucca Shidigera) and mineral micronutrients with a cytokinin-like action containing 1.5% manganese, 1.5% iron and 1% copper being registered in Brazil as foliar fertilizer (Leão et al., 2005).

The preparation of this soil consisted of plowing, harrowing and raising the beds, then opening furrows for planting fertilization. The fertilizations of N and K were carried out as follows: 10% of both nutrients were applied in planting and the rest (90%) in coverage, via fertigation. Planting fertilization with P_2O_5 in the proportion of 40 kg ha^{-1} was applied 100% fifteen days before planting.

The sowing took place in December 2016 in a 162-cell polystyrene tray filled with commercial agricultural substrate "Tropstrato" indicated for the production of vegetable seedlings. The transplantation was performed when the second leaf was completely expanded, fifteen days after sowing. The planting spacing adopted was 2.0 x 0.4 m, with one plant per pit. The plot consisted of three rows of plants, with a central row, being considered as useful area and containing five plants. Hybrid, from *Cantaloupensis* group, with vigorous plants with rounded fruits, orange flesh, small internal seed cavity, brix ranging from 10 to 12° and average weight of 1.2 to 1.7 kg.

After transplanting, the plants were covered with a white polypropylene agrotextile, 1.38 m wide and 15g cm^{-2} grammage. Twenty-five days after transplanting the seedlings, the agrotextile was removed, thus making manual weeding.

For covering fertilization, 126 kg ha^{-1} of N in the form of urea and 135 kg ha^{-1} of K_2O in the form of potassium chloride were applied according to the technical bulletin of Cavalcanti (2008) seven weeks after the transplant.. The following percentages of each nutrient were applied respectively for each week: 1st week = 5.0% N and 7.0% K_2O; 2nd week = 8.0% N and 8.0% K_2O; 3rd week = 10.0% N and 15.0% K_2O; 4th week 15.0% N and 18.0% K_2O; 5th week 20.0% N and 18.0% K_2O; 6th week = 20.0% N and 18.0% K_2O; 7th week = 12.0% N and 6.0% K_2O.

Drip irrigation was performed daily using 0.4 m spaced drippers with flow rate of 2.0 L h^{-1}. Other cultural practices, such as weeding and phytosanitary control, were performed as

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needed. The application of biostimulant was performed in the proposed amounts and times according to the treatment and early in the morning.

Harvesting started, on average, at 73 days after sowing, with the formation of the abscission layer in the peduncle region, a reliable indication of the harvest point of this hybrid.

Fruit yield and quality were evaluated after harvesting: the number of fruits per plant was evaluated by counting in each experimental unit, the average fruit mass (g fruit^{-1}) was evaluated by the ratio. Fruit weight by number of fruits in the plot and total yield (t ha^{-1}) were evaluated by estimating to 1.0 ha^{-1} at experimental level.

The quality characteristics evaluated in the melon came from a sample of four fruits per repetition, totaling sixteen fruits per treatment. The following evaluations were performed: soluble solids (SS) determined with the aid of a digital refractometer, model PR-100 Pallete by ATAGO brand, total acidity (AT) determined according to the (1985), vitamin C content by the Tillmans method; the thickness of the pulp by measuring the median part of the fruit using a digital caliper in mm, the length and diameter of the fruits by using a ruler graduated in (cm) and the fruit shape index by the ratio between their length and diameter.

The data were subjected to analysis of variance at the level of 5% probability by the SAEG 9.0 software. Then, the regression analysis to choose the models that were adjusted based on the biological response, the significance of the F test of the regression analysis of variance, the significance of the parameters of the regression equation and the highest value for the determination coefficient using the Table Curve 2D software.

3. Results and Discussion

After analysis of the experimental data, no significant interaction was observed between the dose and the time of application of the biostimulant in any of the evaluated characteristics ($p > 0.05$). Regarding the isolated factors, soluble solids ($p < 0.0066$), pulp thickness ($p < 0.0164$), length ($p < 0.0194$) and fruit diameter ($p < 0.0078$) were significantly influenced by biostimulant doses and only the total productivity was significantly affected by the time of application of the biostimulant ($p < 0.0274$).

Among the variables related to the formation of melon crop yield are the number of fruits per plant and fruit mass. With the application of the biostimulant it was observed that the number of fruits per plant, the fruit mass and the productivity presented a quadratic response with maximum estimated values of 2.5, 1.42 kg fruct^{-1} and 42.35 Mg ha^{-1} obtained at biostimulant doses of 1.5, 0.9 and 1.4 L ha^{-1}, respectively (Figure 1). Compared to the non-application of the biostimulant (0.0 L ha^{-1} dose) there was an increase in the number of fruits per plant and in total crop productivity of 31.6 and 32.3%, respectively. However, as for fruit mass the lowest value was observed at the dose 2.0 L ha^{-1} of the product with a reduction of 9.5% in relation to its optimal dose of biostimulant which was 0.90 L ha^{-1}.

It can be observed that until the biostimulant dose of 1.5 L ha^{-1}, the number of fruits per plant increased influencing the higher crop yield. From this optimum dose, there was a decrease in the values of these variables, with greater effect for fruit mass, which presented lower value at the highest biostimulant dose of 2.0 L ha^{-1} compared to not applying the product.

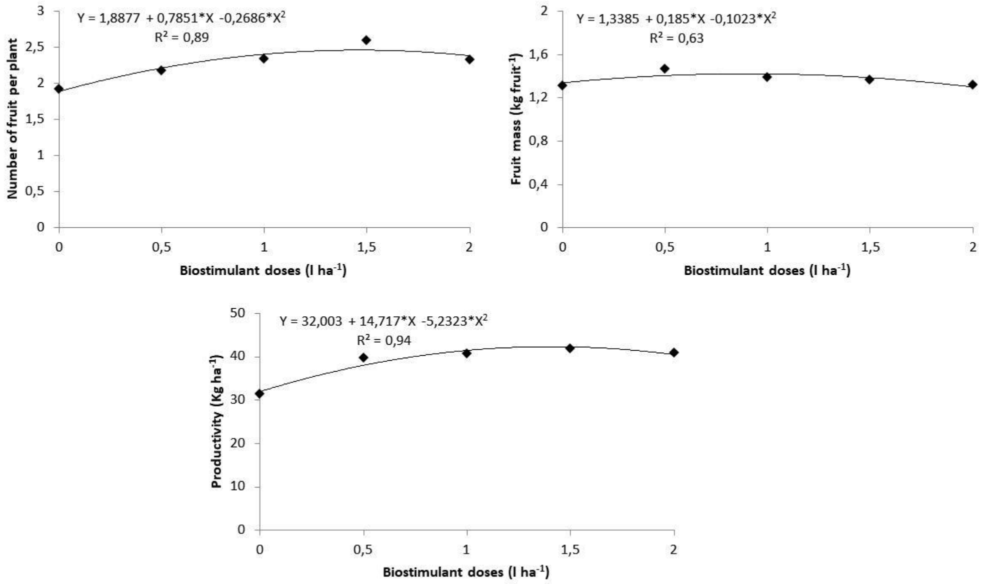
The higher number of fruits in the plant with the application of biostimulant up to 1.5 L ha^{-1} can be attributed to the higher plant growth that led to the formation of more secondary and tertiary branches in which female flowers are found. According to Kauffman et al. (2007) the use of biostimulants promotes plant growth associated with higher emission of female flowers when applied in low amounts, as observed in this experiment.

Higher doses of biostimulant ranging from 0.9 to 2.0 L ha^{-1} resulted in a reduction in fruit mass, probably due to the higher number of fruits in the plant of 31.6% when compared to 0.01 L ha^{-1} biostimulant.

Studies point to the effect of foliar application of plant regulators and foliar fertilizers on the development and production of cucurbits. In Tetsukabuto hybrid pumpkin there was an increase in the number of fruits per plant and fruit mass by spraying the 2,4-D plant growth regulator, with an increase in crop yield of 123.8% at a dose of 212.8 mg L^{-1} (Pereira et al., 2012). Zucchini crop showed a significant increase in flower number and average fruit weight by the application alone or associated with the Biozyme® TF plant regulator and K-fol® leaf fertilizer (Matos et al., 2017).

On the other hand, Martins et al., (2013) found a contradictory result to that observed in this work when using the Crop Set® biostimulant in watermelon culture and observed significant differences in the fresh mass of Quetzali and Style fruits. According to these authors, this increase in watermelon fruit mass is associated with the composition of the product, which according to the company is composed of micronutrients such as sulfur, copper, iron and manganese that stimulates and regulates the flow of sap in the plant. Also according to the same authors, the use of biostimulant may have increased the translocation flow of the photoassimilates produced by the sources to the drains, causing a greater accumulation of fruit mass.

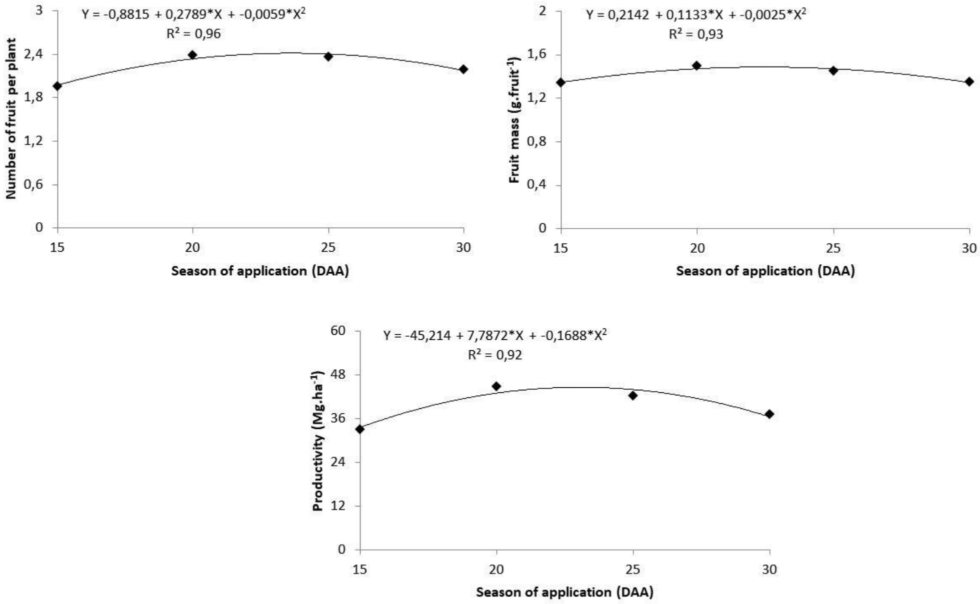
Figure 1: Response functions adjusted for number of fruits per plant, fruit mass and total melon fruit yield as a function of biostimulant doses. CCTA/UFCG, Pombal – PB.



Observing the behavior of these production-related variables as a function of the time of application of the biostimulant we can also observe that there was a quadratic response to the number of fruits per plant, fruit mass and total crop yield with estimated maximum values of 2.4; 1.48 kg fruct^{-1} and 44.58 Mg ha^{-1} obtained at the times of application of the biostimulant of 23.6; 22.5 and 23.1 days before harvest (Figure 2).

The application of the biostimulant closest to the harvest, that is, at 15 days, was not beneficial for the increase of these production-related variables. In this case, there was an increase in the number of fruits per plant and yield of 21.8 and 32.7%, respectively, in relation to the application of the product until 23.6 and 22.5 days before harvest. This increase may be related to the stage of phenological development of melon, since the fruit was already formed, thus providing greater mass accumulation due to the expansion of cells and syntheses of photoassimilates stimulated by the applied product and, consequently, positively impacting the fruit productivity (Vendruscolo et al., 2017).

Figure 2: Response functions adjusted for number of fruits per plant, fruit mass and total melon fruit yield as a function of biostimulant application times. CCTA/UFCG, Pombal – PB.

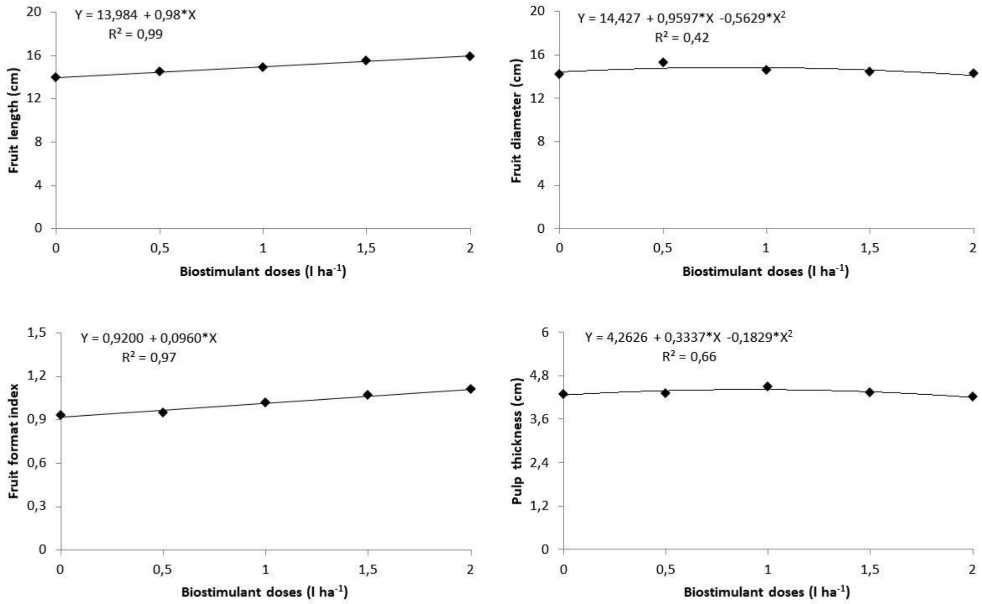


However, as for the mass of melon fruit the lowest value was observed at the time of application of biostimulant at 30 days before harvest resulting in a reduction of 11.4% compared to its optimum application time which was 22.5 days before harvest. The effect of biostimulant application when performed later than 30 days before harvest did not result in fruit gain, probably due to freshly fixed fruits 30 days before harvest with high cell division rate. However, its cell expansion will occur at a more advanced stage of fruit development. Thus, activation of photoassimilate fluxes for fruit growth via cell expansion promotion can result in larger mass fruits when the cell division phase is more stabilized.

According to Souza et al. (2010), the average weight of melons accepted for export varies between 1.2 and 2.5 kg, thus the results show that despite the difference found, fruits submitted to biostimulant doses and at different application times presented average weight 1,454 g fruto^{-1} and are within the accepted limits for commercialization.

Regarding the variables length and shape index of the fruits, an increasing linear response was obtained as a function of biostimulant doses (Figure 3). Thus, there was an increase of 14.0 and 20.6% in fruit length and shape index when the biostimulant dose was changed from 0.0 to 2.0 L ha^{-1}; However, in relation to fruit diameter and melon fruit pulp thickness, a quadratic response was obtained with maximum values of 14.8 and 4.4 cm found in the biostimulant doses of 0.85 and 0.92 L ha^{-1} respectively (Figure 3). Obtaining these optimal doses of biostimulant showed a reduction of 5.3% in the values of both diameter and thickness of the fruit pulp in relation to the biostimulant dose of 2.0 L ha^{-1}.

Figure 3: Response functions adjusted for fruit length and diameter, ripening index and thickness of melon fruit pulp as a function of biostimulant doses. CCTA/UFCG, Pombal – PB.



It is noteworthy that the higher value of the fruit length obtained with the increase of the biostimulant dose up to 2.0 L ha^{-1} contributed decisively to the increase of the fruit format index with the increase of the biostimulant doses made them less spherical by increasing the relationship between fruit length and diameter. We can also observe that the maximum estimated values of fruit diameter and pulp thickness with biostimulant doses of 0.85 and 0.92 L ha^{-1} are in agreement with the estimated maximum value for fruit mass obtained in with the biostimulant dose of 0.90 L ha^{-1}.

The further development of the fruit after application of Crop Set® can be explained by its cytokine-like action, inducing cell division and thus stimulating cell growth in plant tissues (Aroucha et al., 2018). According to Taiz and Zaiguer (2017), gibberellic acid and cytokine play an important role in cell division, providing greater growth for vegetables.

Results similar to those obtained in this study were evidenced by Martins et al., (2013) who also found significant effects on watermelon fruit pulp thickness between the Quetzali and Style varieties. According to the same authors, this is a genetic trait that may decrease the response margin for external factors, such as the application of biostimulant. Vendruscolo et al., (2017) found no effect of amino acid-containing biostimulant doses on the physical characteristics of 'Cantaloupe' melon.

Regarding the time of application of the biostimulant, a quadratic response was observed under the length and diameter of the fruit with estimated maximum values of 15.8 and 15.1 cm obtained at the times of application of the biostimulant of 21.3 and 22.7 days before harvest (Figure 4). These data led to a reduction in fruit length of 3.5% in value when the product was applied later than 30.0 days before harvest. However, when it comes to the diameter of the fruit, there was a reduction in its value when the application of biostimulant occurred closer to the harvest, 15 days before harvest.

The application of this product that has similar action to cytokine, in effect, both in number and expansion of cells may explain the increase in length, diameter, and thickness of fruit pulp, in the present work, with the use of Crop Set® biostimulant. According to Taiz and Zaiger (2017) the greater fruit development after the application of cytokine-based plant regulators can be explained by the fact that their action induces cell division and stimulate cell growth in plant tissues. These authors also emphasize that the use of plant regulators belonging to the cytokine group causes fruit size increase in several species.

For the melon fruit pulp format and thickness index, an increasing linear response was found in relation to the time of application of the biostimulant with an increase of 1.9 and 7.9%, respectively, until the time of application 30 days before harvest (Figure 4). This result was expected because the format index is obtained by the ratio between the length and diameter of the fruit. Thus, the shorter fruit length recorded with the application of biostimulant at 30.0 days before harvest led to the higher value of this index in fruits harvested with the application of biostimulants at the same time.

The melon fruit format index is an important quality attribute for the definition of classification and standardization, and can determine the best acceptance and valorisation of the product for certain types of market and for the definition of the packaging and arrangement of the fruit inside. Therefore, the format index close to 1 is preferable because, above and below this value, the fruits are, respectively, elongated and flattened, compromising their accommodation in the packages (Queiroga et al., 2009).

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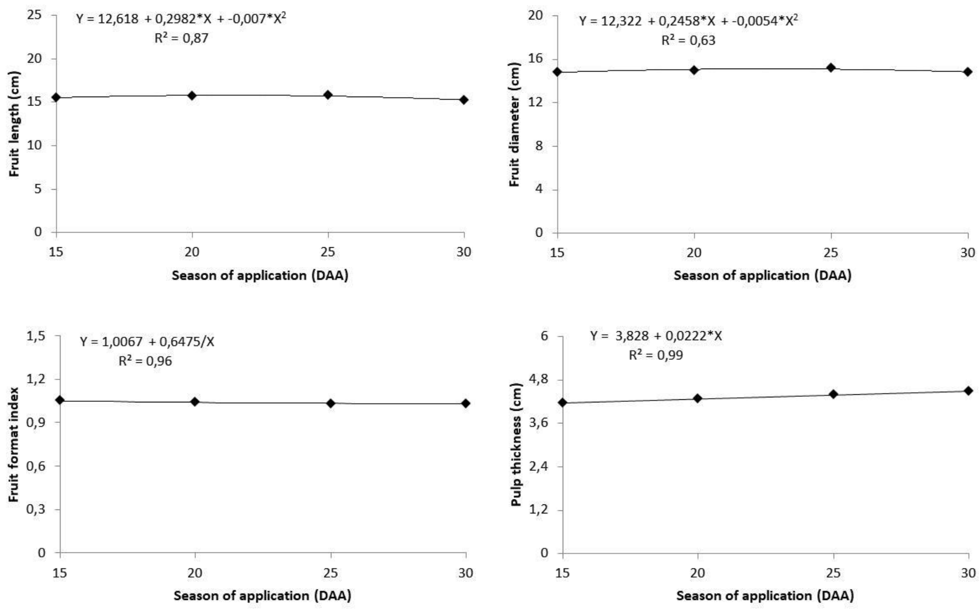
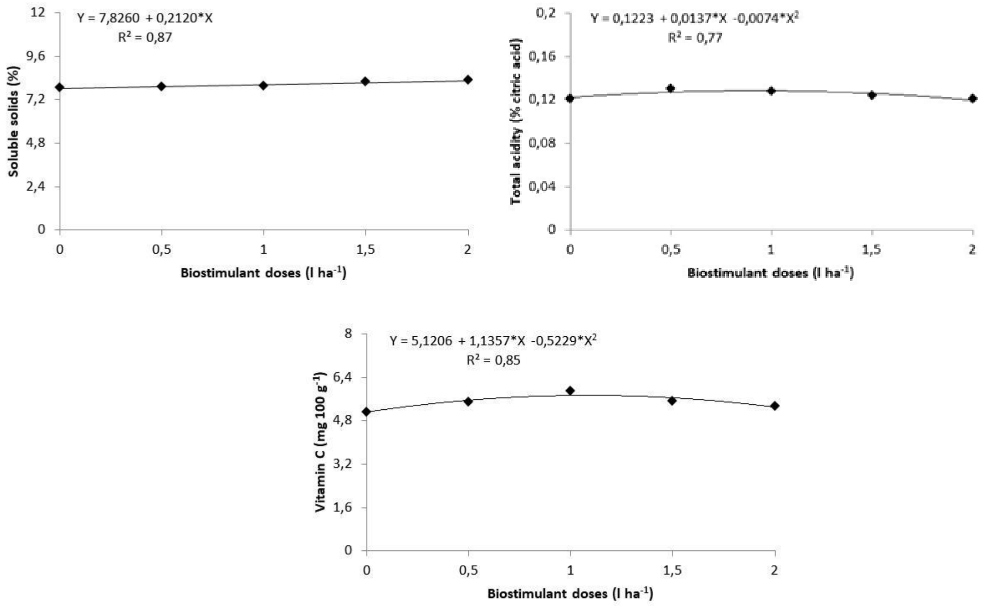
Figure 4: Response functions adjusted for fruit length and diameter, melon fruit pulp thickness as a function of biostimulant application times. CCTA/UFCG, Pombal – PB.



With the continuity of the experimental data analysis, an increasing linear response was observed for the soluble solids content as a function of the biostimulant doses applied in the melon; In this variable, an increase of 5.5% in soluble solids was obtained when the biostimulant dose increased from 0.0 to 2.0 L ha^{-1}; However, in relation to the total acidity and vitamin C in the melon fruit pulp, a quadratic response was obtained with maximum values of 0.128% citric acid and 5.74 mg 100g^{-1} found in biostimulant doses of 0.92 and 1.09 L ha^{-1}, respectively (Figure 5). Higher doses than previously reported showed a 7.0 and 12.1% reduction in total fruit pulp acidity and vitamin C concentration in relation to 0.01 L ha^{-1} biostimulant dose.

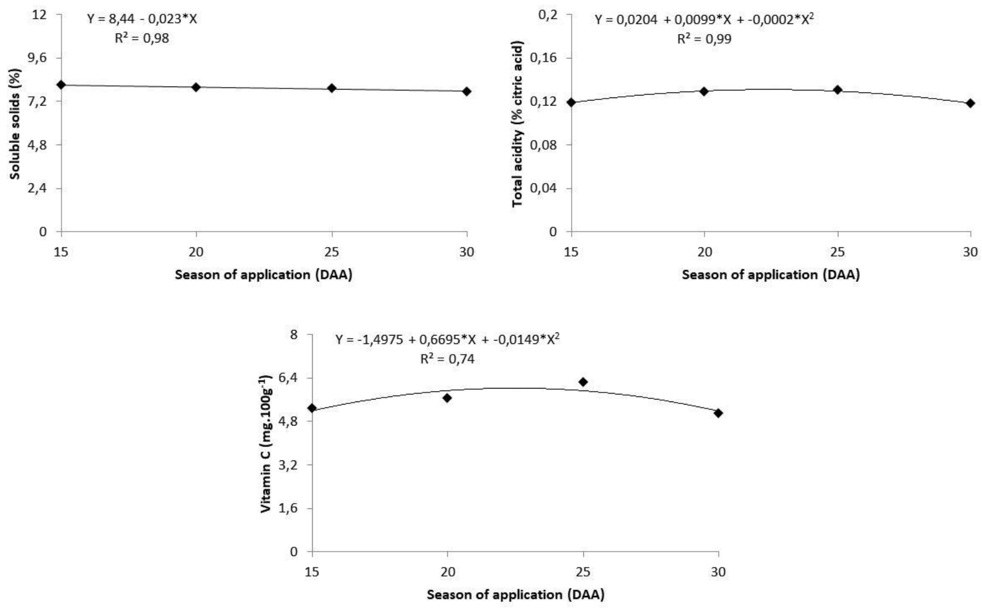
Figure 5: Response functions adjusted for soluble solids content, total acidity and vitamin C in melon fruit pulp as a function of biostimulant doses. CCTA/UFCG, Pombal – PB.



This result is related to the increase in cell division and stretching activity, provided by the action of hormones that are part of the biostimulant (Taiz et al., 2017). Thus, the ability of the fruits to act as strong drains of photoassimilated compounds is increased, increasing the fixation of the fruit to the plant and possibly causing a greater accumulation of sugars in the fixed fruits (Moreira et al., 2014). Nasir et al., 2016 also observed that the use of plant extract-based biostimulants combined with mineral nutrients act as exogenous inducers of hormones (auxins, cytokines and gibberylins) and plant metabolism that favor a greater accumulation of total soluble solid, total acidity and protein content vitamin C in fruits.

Additionally, increasing the biostimulant dose up to 2.0 L ha^{-1} resulted in an increase in soluble solids values and a reduction in total acidity and vitamin C values. This indicates that for the present study, the biostimulant may have promoted slight increase in the synthesis of organic acids, possibly due to the gibberellin and cytokine hormones that can cause changes in fruit ATT (Taiz and Zeiger, 2017). According to Costa et al., (2017) it is natural that as the total soluble solids increase the total titratable acidity will occur. Also according to the same authors, the increase of soluble solids is associated with the degradation of complex carbohydrates such as cellulose, pectins and hemicellulose, to monosaccharides such as glucose and fructose, which favors the sweetness of fruits.

Figure 6: Response functions adjusted for soluble solids content, total acidity, ripening index and vitamin C in melon fruit pulp as a function of biostimulant application times. CCTA/UFCG, Pombal – PB.



When evaluating the biostimulant application time factor, a decreasing linear response was observed for soluble solids with a 4.4% reduction when biostimulant was applied at 30.0 to 15.0 days before harvest (Figure 6). However, in relation to total acidity and vitamin C, a quadratic response was registered with maximum values of 0.131% vitamin C and 6.0 mg $100g^{-1}$, respectively, obtained at the times of application of the biostimulant of 22.4 and 22, respectively 5 days before harvest (Figure 6). In relation to total acidity and vitamin C there was a reduction of 11.0 and 16.4% in their values when the product was applied at 30.0 days before harvest.

The highest value of soluble solids observed with the application of the biostimulant closest to the harvest is related to the ability of the drains to attract the photoassimilates. In this final phase of the crop cycle, fruits have already passed through the division phase and cell expansion continues at a low rate (Queiroga et al., 2009). Thus, the beneficial effect of biostimulant will be allocated more to sweetening of fruits than to their growth. In addition, the application of this cytokine-based plant regulator may have contributed to the reduction of leaf senescence near harvest, thus maintaining a leaf area to support the production and translocation of photoassimilates for sweetening of fruits.

Regarding total acidity and vitamin C, the data varied little in relation to the time of application of the biostimulant. According to Cohen et al., (2014) although acidity influences fruit flavor, slight variations in acidity levels are of little significance for melons and watermelons due to the low concentration. Martins et al., (2013), observed that the application of Crop Set® vegetable biostimulant, reduced fruit length and increased total soluble solids and titratable acidity. Such observed differences may be due to cultivars, management practices, edaphoclimatic conditions, which alter the growth rate of the plants and the partition of assimilates between the plant's organs and influencing the accumulation of sugar in the fruit (Queiroga et al., 2009).

4. Conclusion

The best time to apply the Crop Set® biostimulant was at 23.1 days before harvest, which provided the highest total melon productivity of 44.58 $Mg.ha^{-1}$.

The 1.5 $L.ha^{-1}$ dose of the Crop Set® biostimulant induced the best fruit production per plants - 2.4 fruits.

The biostimulant dose of 2.0 $l.ha^{-1}$ increased the content of soluble solids by 5.5% when the product was applied 15 days before harvest.

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