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AQUEOUS EXTRACT OF TIRIRICA, BIO-STIMULANT AND MICRONUTRIENT IN BEET PRODUCTIVITY AND QUALITY PARAMETERS

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ABSTRACT - The use of stimulants in the beet crop can serve as a complement in the production and quality of the final product. In order to compare and evaluate the effects of physiological activators and aqueous extracts of tiririca on the parameters of beet quality and productivity, an experiment was conducted at the field in the municipality of Formosa do Oeste (Paraná, Brazil), in a typical dystroferric RED LATOSOL. The experimental design was randomized blocks, with four treatments (T1 - control, T2 - Stimulate® 0.004%, T3 - tiririca (*Cyperus rotundus* L.) 10%, T4 - Starter® 0.004%), with seven replicates. The seedlings were kept in the soil for 24 h in each treatment and then taken to the field and planted in beds. Leaf height (cm), number of leaves, stem length (cm), root diameter (cm), slight effects (%), serious effects (%) and productivity (t ha^{-1}) were evaluated. Micronutrient application increased yields by around 5 t ha^{-1}. The aqueous extract of tiririca and biostimulant presented a larger root diameter in the beet.
Keywords: *Beta vulgaris* L., *Cyperus rotundus* L., post-harvest quality, root diameter, root damages.

EXTRATO AQUOSO DE TIRIRICA, BIOESTIMULANTE E MICRONUTRIENTES NA PRODUTIVIDADE E PARÂMETROS DE QUALIDADE DA BETERRABA

RESUMO - O uso de estimulantes na cultura da beterraba pode servir como complemento na produção e na qualidade do produto final. Com o objetivo de comparar e avaliar os efeitos de ativadores fisiológicos e extratos aquosos de tiririca nos parâmetros de qualidade e na produtividade da beterraba, um experimento foi conduzido à campo no Município de Formosa do Oeste (Paraná, Brasil), em Latossolo Vermelho Distroférrico típico. O delineamento experimental utilizado foi blocos casualizados, com 4 tratamentos (T1 - testemunha, T2 - Stimulate 0,004%, T3 – Tiririca (*Cyperus rotundus* L.) 10%, T4 - Starter 0,004%), com sete repetições. As plântulas permaneceram 24 h em imersão em cada tratamento e posteriormente levadas a campo e plantadas em canteiros. Avaliaram-se a altura de plantas (cm), número de folhas, comprimento da haste (cm), diâmetro da raiz (cm), efeitos leves (%), efeitos graves (%) e produtividade (t ha^{-1}). A aplicação de micronutrientes aumentou a produtividade em torno de 5 t ha^{-1}. O extrato aquoso de tiririca e o bioestimulante apresentaram maior diâmetro de raiz na beterraba.
Palavras-chave: *Beta vulgaris* L., *Cyperus rotundus* L., qualidade pós-colheita, diâmetro de raízes, danos de raízes.

INTRODUCTION

Uniformity in the beet development (*Beta vulgaris* L.), is a determinant factor in vegetables productivity and management of natural resources, due to the greater soil volume explored by seedlings with full water use (TOUREIRO et al., 2007). The beet belonging to Quenopodiaceae family, has tuberous root, with globular shape which develops in the shallower soil depth, almost to the surface, originates in temperate regions in Southern Europe and North Africa, cultivated in the winter in Brazil for being period with greater adaptability (SHRESTHA et al., 2010).

In Brazil South and Southeast regions, occurs low rainfall rates on winter, with reduction in the air humidity and thewater potential in the soil, where the crop nutrient absorption and the final product quality are affected because of the short cycle of culture and the large water amount needed to make its constitution (FILGUEIRA, 2008).

In addition to the aforementioned factors, use of commercial products and organic substances that promote rooting, with proven relationships of culture, climate and soil, are decisive in irrigation practice, in order to optimize the amount of water applied to crops (MORILLO-VELARDE, 2010). Beet culture adapts very well to transplantation in direct seeding system and seedlings production is considered the most determining factor in the productive process (FILGUEIRA, 2008).

In this context, tiririca aqueous solutions are known for their allelopathic effects, with scientific reports

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on the phenols presence, flavonones, saponins e tannins (ANDRADE et al., 2009), with high IBA levels, used to stimulate the rooting of several species (DIAS et al., 2012).

There is also the use and recommendation of bioregulators in diverse cultures, which have in their composition plant hormones, with a view to mediating a wide range of developmental processes in plants, many of which involve biosynthetic and catabolic interactions, which together control the homeostasis of plant hormones (ELLI et al., 2016).

The development of field experiments, unlike the experiments carried out in greenhouse, bring information to family farming producers of vegetables that do not have a protected environment for their production, with assistance in the decision about the management submitted to seedlings, because the production costs for pH correction and initial development through large amounts of fertilizers, may exceed 25% of the total cost of production (ALVES et al., 2008).

The objective of this study was to evaluate the effect of the aqueous extract of tiririca, biostimulant and micronutrients in the rooting promotion of beet seedlings and their influence on crop quality and productivity.

MATERIAL AND METHODS

The experiment was conducted in municipality of Formosa do Oeste (Paraná, Brazil), private property with an average elevation of 363 m, latitude 24°14’16” S and longitude 53°18’07” W. The climate of this region, according to the Köppen classification is subtropical humid *Cfa* (ALVAREZ et al., 2013), with average annual precipitation between 1600 and 1800 mm and relative humidity between 70-75% (CAVIGLIONE et al., 2000). The annual average temperature is in range of 22-23°C.

The soil of this region is classified as typical Dystrophic RED LATOSOL (EMBRAPA, 2013), with clay, silt and sand contents of 640, 210 and 150g kg^{-1}. For the chemical analysis of soil, samples were collected at a depth of 0-20 cm and they were sent to the chemical analysis laboratory of Unithal (Campinas, São Paulo, Brazil). The results of the chemical analyzes are presented in Table 1.

TABLE 1 - Chemical attributes of samples collected before the experiment installation.

Depth	P	OM	pH $CaCl_2$	Ca^{+2}	Mg^{+2}	K^{+}	H + Al	Al^{+3}	CEC	BS	Ca/Mg
m	mg dm^{-3}	g dm^{-3}		---------------------------------- $cmol_c$ dm^{-3} -------------------------------------							
0 - 0,20	79,00	7,70	5,50	9,50	3,60	0,50	3,40	0,00	21,50	6,56	3,64

Depth	V	Al	Ca	Mg	K	S-SO_4^{-2}	B	Mn	Zn	Cu	Fe
m	----------- % of saturation on CTC ----------					-------------------------mg dm^{-3}-------------------------					
0 - 0,20	84,19	0,00	44,20	16,07	23,33	16,40	0,30	57,50	50,00	19,00	49,00

P, K^{+}, Cu, Zn, Fe e Mn = Mehlich^{-1}; Ca^{2+}, Mg^{2+} e Al^{3+} = KCl; OM = Walkey Black; pH = calcium chloride; H + Al = Plug SMP; $S(SO_4)^{-2}$ = Monocalcium Phosphate; B = Barium chloride (LANA et al., 2010).

Initially, the seeds of Early Wonder beet were planted in two styrofoam trays containing 200 cells filled with commercial Bioplant® substrate, that remained under sombre conditions, with irrigation twice a day with watering can. After 40 days, the seedlings were removed from the tray and divided equally into four plastic pots with 2.5 L of capacity for application of treatments.

The experiment was conducted in complete randomized block design with 4 treatments and 7 replicates. The treatments consisted of T1 - witness only with distilled water; T2 - commercial product Stimulate® (biostimulant at a concentration of 0.004%); T3 - solution from tubers of tiririca at a concentration of 10% and T4 - commercial product of Starter® (micronutrients on concentration of 0.004%).

To prepare the solution with Stimulate® was added 10 mL of the product in 2.5 L of distilled water. The product is composed of three plant hormones: 0.009% kinetin, 0.005% giberelic acid and 0.005% indolbutiryc acid (BETOLIN et al., 2010). To prepare the tiririca solution, 500 g of tubers were collected in rural property located in the municipality of Corbélia (Paraná, Brazil), they were washed and dried on paper towel, taken to the blender and the volume of 2.5 L was filled with distilled water, after crushing 250 mL of the extract was sieved to make the 10% concentration.

Treatment with Starter® was also prepared with the addition of 10 mL of the product in distilled water. This commercial product has on its composition of 5% nitrogen (N), 4% sulfur (S), 0.3% boron (B), 0.3% copper (Cu), 5% manganese (Mn); 0.05% molybdenum (Mo), 3% zinc (Zn), with 5% organic carbon, characterized by humic and fulvic acids.

The extracts were placed in plastic vessels containing 100 beet plants each and they remained immersed for 24 h. Immediately after completing the time, the seedlings were taken to the field and planted in beds in the depth of 0.01 m, with line spacing of 0.30 m and plant spacing of 0.07 m.

For the beds preparation were carried out two grading followed by lifting. They were divided into plots where each plot was 0.50 m in length by 4 lines of 0.30 m wide, with total area of 0.60 m² and floor area of 0.30 m^2, because the lateral lines are considered border. In all the plots were applied the dose equivalent to 5 kg ha^{-1} of Borosol, composed of 30% boron before planting. Irrigations were performed daily with watering sprinklers, providing an estimated water depth of 10 mm day.

The evaluated parameters were plant height and leaf number 20 days after planting and 80 days after transplanting the seedlings to the field was harvested, where the diameter of the root (cm) and the length of the stem (cm) were evaluated. To determine the effects of treatments on the commercial value of beet were evaluated the percentage of roots with slight effects: discoloration (%), surface damage (%), nozzle (which is characterized by excess nozzle) (%) and deformation (%). In addition to the mild effects, serious effects: rot (%), deep damage (%) and wilt (%). For determining productivity, estimation was made by weighing the beets of the area of 0.30 m^2 and extrapolating the yield per hectare.

The data were submitted to analysis of variance. With a significant effect, the means were submitted to the Tukey test at 5% probability. Statistical analysis was performed using Sisvar program (FERREIRA, 2011).

RESULTS AND DISCUSSION

In the biometric parameters evaluated in the initial development of beet, the control treatment showed a significant difference of the other treatments. Therefore, there was a response of the control to the phytoregulators and micronutrients in the initial development of beet (Figure 1). The seedlings that were treated had an increase at least 0.92 cm, indicating a marked response in the early beet development.

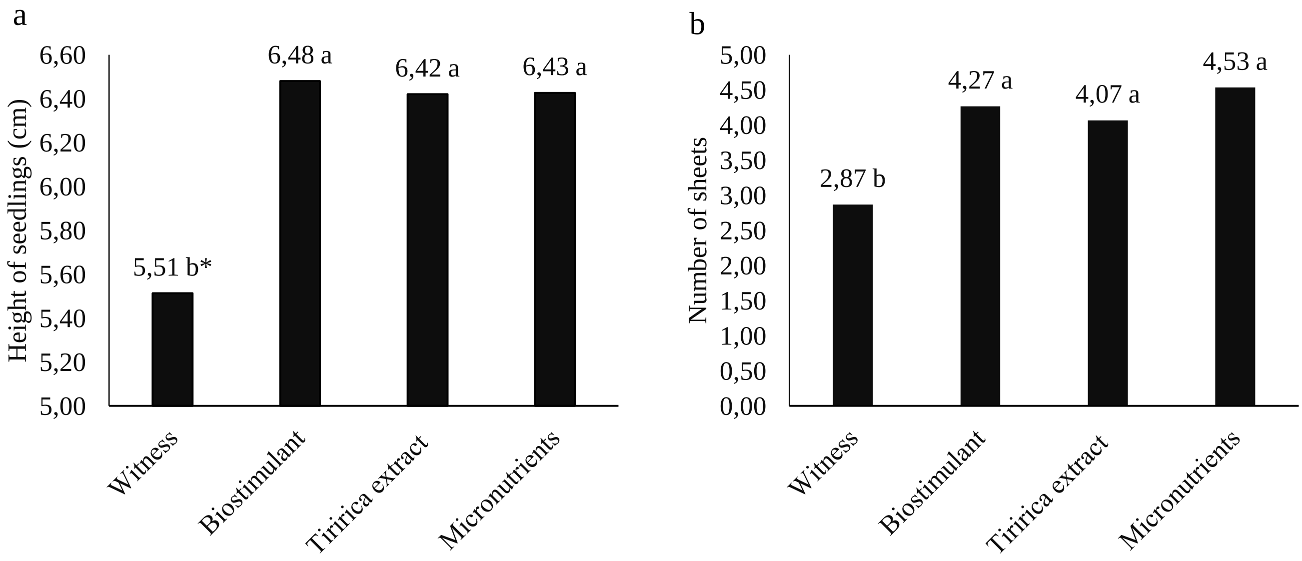

FIGURE 1 - Seedlings height in centimeters (a) and leaves number (b) of beet crop due to different treatments. *Witness = control; Biostimulant = Stimulate® (0.004%), Tiririca extract = aqueous extract of tiririca (*Cyperus rotundus* L.) 10%, Micronutrients = Starter® (0.004%). Same lowercase letters are statistically the same.

When they related data of the same biometric variables evaluated in this study, Granjeiro et al. (2007), verified that beet culture has an initial development responsive to nutritional and phytotechnical management, in order to seek greater development of the aerial part with the objective of improving the establishment bodies responsible for the source of photo assimilates.

As for the effect of biostimulants and aqueous extract of tiririca on leaves number (Figure 1b), this is an effect considered extremely important in the autumn / winter climate conditions, because this characteristic affects the seedlings power of intercepting solar radiation, which will interfere in the reallocation of the photosimilates in the plant (FERNANDES et al., 2010).

The biostimulant treatment, due to its composition being formed by kinetin, 0.005% giberelic acid and 0.005% indolebutiryc acid, showed on emergency speed an answer 26% greater, 25% higher plant height and 33% higher leaf number than the control treatment (Figure 1).

As for the aqueous extract of tiririca, its composition is formed by: cyproten, cypera-2,4-dien, α-copaen, cypereno, α-selineno, rotundeno, valenceno, γ-lang-2,4-dieno, γ-gurjuneno, transcalameneno, δ-cadieno, γ-calacoreno, epi-α-selineno, α-muroleno, γ-muroleno, cadaleno, notkateno, cyperotundano, isocyperol, α-cyperona, isorotundeno, cypero-2,4(15)-dieno, norotundeno, cyperadiono, β-selineno e β-cyperona, which are terpenoids, natural substances, or secondary metabolites of plant origin, especially conifers, of general $(C_5H_8)_n$ chemical formula (DIAS et al., 2012).

Using aqueus extract of tiririca, Câmara et al. (2016) verified its efficiency for surviver and budding percentage of acerola plant minicuts, which can be considerable in the production cost, and the extract can be produced at home by the producer.

Treatment with macro and micronutrients, with 5% N; 4% S; 0.3% B; 0.3% Cu; 5% Mn; 0.05%, Mo; 3% Zn, com 5% of organic carbon, characterized by humic and fulvic acids. Among the micronutrients B, which has action on the beet quality, and the application of correct doses of this micronutrient decreases the incidence of lesions on roots (TIVELLI et al., 2011).

Zn is considered an element of great importance for plants, when participating as a component of a large number of enzymes, metabolism of carbohydrates, proteins and phosphates, besides the auxins structure formation, phenols metabolism and increase in cell size and multiplication (TAIZ et al., 2017). These nutrients did not present critical levels reached in the soil (Table 1).

For stem length (CT) and root diameter (DR), the control treatment showed the lowest development rates with 2.47 for CT and 17.93 for DR, where the highest level for CT and DR were found in the aqueous extract of tiririca (Figure 2). The analysis of variance results showed that there was no significant effect on stalk elongation for treatments with products.

The compositions present in tiririca have effects on the processes of root systems formation and development (SOUZA, 2012). An experiment carried out by Silva et al. (2008), shows that there was development in relation to the stem growth due to the influence of the biostimulator, with contrasting results to this work.

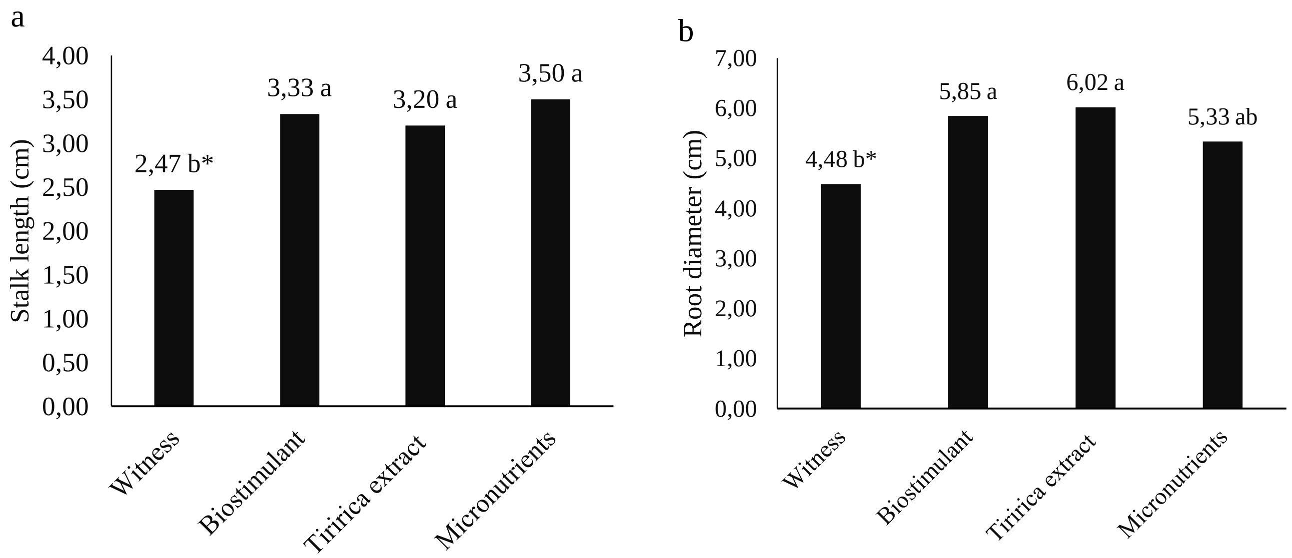

FIGURE 2 - Stalk length (cm) (a) root diameter (cm) (b) of beet crop due to different treatments. Witness = control, Biostimulant = Stimulate® (0.004%), Tiririca extract = aqueous extract of tiririca (*Cyperus rotundus* L.) 10%, Micronutrients = Starter® (0.004%). Same lowercase letters are statistically the same.

The results show superiority with regard to root development by the aqueous extract of tiririca use followed by the use of biostimulators, statistically without differences between them. The use of micronutrients, although statistically did not show differences with the extract and biostimulator, showed less root development along with the control.

Cavalcante et al. (2016) reports that beet size is influenced by the different doses of aqueous extract of tiririca, no which the concentration of 100% during the imbibition of the seed provided better results in relation to seed germination and greater root development.

From the commercial value evaluations of the beet harvested from the experiment, effects which are: discoloration, surface damage, nozzle and deformation; the treatments were not responsible for the observed damages according to the classification standard defined by the Horticulture Quality Center of CEAGESP (HORTIBRASIL, 2018) (Figure 3).

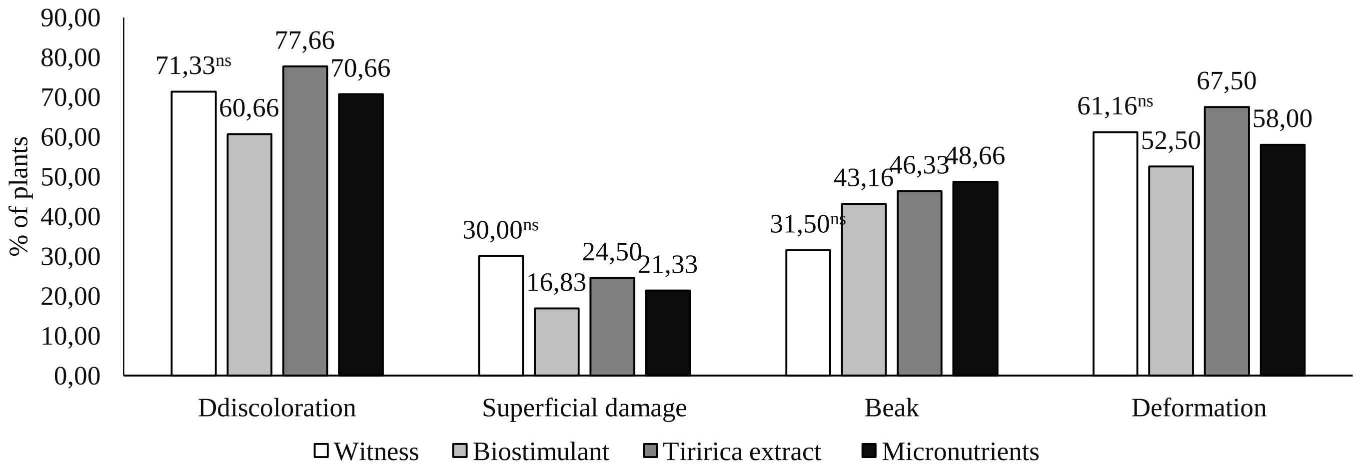

FIGURE 3 - Light effects: discoloration, superficial damage, beak and deformation, beet crop due to different treatments.

The discoloration was the effect that most hit the beets and superficial damage were the least pronounced. These characteristics substantially reduce the profit of horticulturists, because the acceptance or rejection of vegetables depends on the appearance, aroma, beyond coloring, which is the most important factor in appearance and greater development (HERNANDES et al., 2007).

This rejection of consumers leads to an increase in post-harvest losses especially for vegetables with high nutrients water content which maintains its biological processes and becomes non-consumable quickly (CHITARRA; CHITARRA, 2005).

In severe effects, the percentages of roots with rot or wilt were not influenced by treatments. However, deep damage has been found in the treatment with commercial product based on micronutrients, which presented more than 10% of this characteristic, maximum tolerance limit for severe defects (Figure 4).

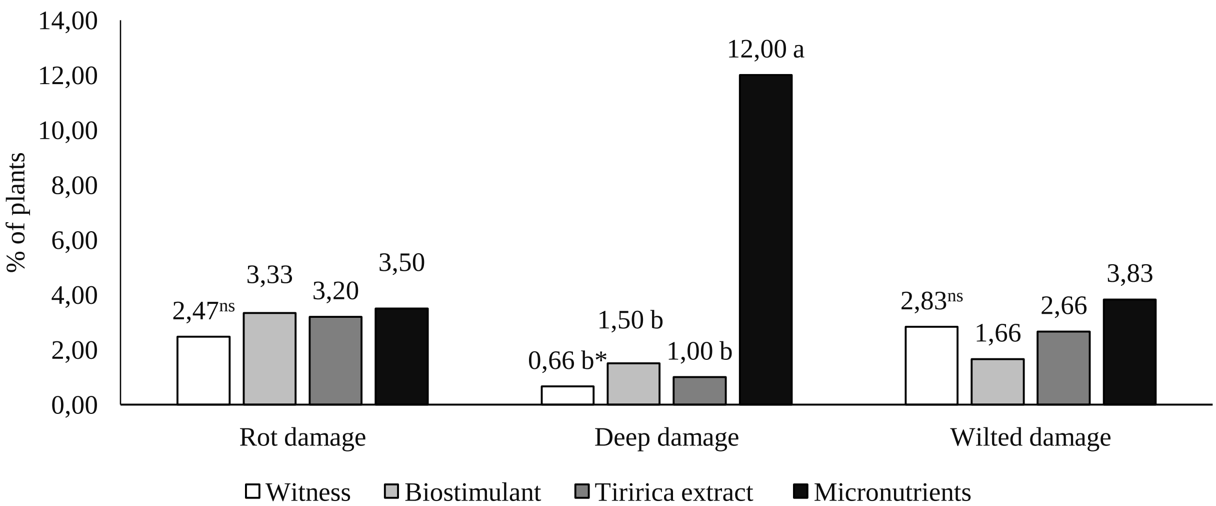

FIGURE 4 - Serious effects: rot, deep and wilted damage, beet crop due to different treatments. Witness = control, Biostimulant = Stimulate® 0.004%, Tiririca extract = aqueous extract of tiririca (*Cyperus rotundus* L.) 10%, Micronutrients = Starter® (0.004%). Same lowercase letters are statistically the same. ^{ns} = not significant to 5% probability of error.

The rot, deep damage and wilt defects, are serious defects that compromise appearance, the conservation, which restricts or makes the vegetables sale unviable. Beets that are not marketed can return to the field as organic fertilizer, because the plants with high production of biomass and rich in nutrients incorporated to the soil improve and retain the chemical properties, physical and biological properties of soil (OLIVEIRA et al., 2015).

Figure 5 shows the yield of beet in t ha^{-1} where there was a significant difference between treatments. Treatment with the commercial product composed by micronutrients presented the highest productivity in comparison to other treatments and control.

Despite the micronutrients B, Zn, Cu and Mn, be present on the soil of the experiment (Table 1 - the micronutrient Mo was not analyzed in the soil of the experiment), test these micronutrients addition to beet seedlings and the response in productivity is important for the family farmer, given that answers contained in literature demonstrate responses of a substantial increase in productivity.

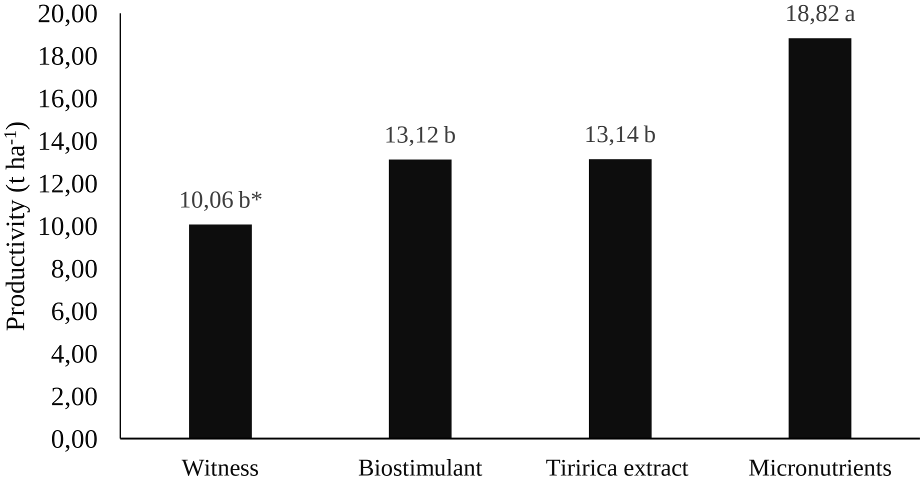

FIGURE 5 - Productivity (t ha^{-1}) according to the treatments. Witness = control, Biostimulant = Stimulate (0.004%), Tiririca extract = aqueous extract of tiririca (*Cyperus rotundus* L.) 10%, Micronutrients = Starter (0.004%). Same lowercase letters are statistically the same. ^{ns} = not significant to 5% probability of error.

The micronutrients B and Zn, support the initial processes of stretching and loosening of cell wall for the full seedlings development, both because they are constituents of the cell wall with the B, both as enzyme activators and essential for tryptophan, precursor of hormones like auxin (KIRKBY and RÖMHELD, 2007). The responses to Cu, Mn and Zn and the beet evidences use in the literature are incipient and scarce (OLIVEIRA et al., 2017).

According to Sediyama et al. (2011) in beet productivity studies shows that high concentrations of micronutrients in the soil increase the export of these in the plant. In contrast to the results found, Kurtz and Ernani (2010) concluded that the use of micronutrients in onion bulbs does not alter their productivity characteristics.

To evaluate the dose response of N, in the presence and absence of S, B, Zn and Mo at doses of 50, 21 and 0.01 kg ha^{-1}, Oliveira et al. (2017) conducted a field experiment in Hapless Cambisoil and evidenced that in the presence of micronutrients and absence of S, in all N doses the treatments did not differ from the control in dry matter and productivity. According to the authors, on S presence and the micronutrients tested and in the dose of 100 kg ha^{-1} the roots and shoot dry matter increased more than 100%, that is, they doubled.

The stimulants can be beneficial to the beet culture due to the nutrient supplement on production and increase on productivity and quality of the final product. Given the above, it is necessary to research on future work such as other doses or other stimulants products.

CONCLUSIONS

The application of micronutrients increased yields around 5 t ha^{-1}. The aqueous extract of tiririca and biostimulant presented a larger root diameter in the beet.

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