Scientia Agraria Paranaensis – Sci. Agrar. Parana.
ISSN: 1983-1471 – Online

DEVELOPMENT AND PRODUCTIVITY OF TWO BEET GENOTYPES FOR FERTILIZATION

Daniel Mocelin Silveira[1*], Flávio Corrêa de Carvalho[1], Gustavo Pailo Mariano[1], André Luiz Oliveira de Francisco[1]

SAP 24070 Received: 04/02/2020 Accepted: 18/05/2020
Sci. Agrar. Parana., Marechal Cândido Rondon, v. 19, n. 3, jul./sep., p. 221-228, 2020

ABSTRACT - Beet needs a high demand of nutrients to improve its development and productivity. The objective of this work was to evaluate the effect of fertilizer forms in the development and productivity of the beet crop. The experiment was carried out in the experimental area of the Fazenda Escola of the Higher Education Center of Campos Gerais, located in the city of Ponta Grossa-PR, between September and November 2018. The experimental design was randomized blocks in a 2x4 factorial scheme [2 genotypes of beet (Boron hybrid and Tall Top Early Wonder cultivar) x 4 forms of fertilization, T1 - control (without fertilization), T2 - poultry litter, T3 - bovine manure and T4 - NPK], containing four repetitions. The harvest was carried out at 75 days after transplanting the seedlings, harvesting five plants from each plot to carry out the analyzes, thus evaluating the number of leaves per plant, height of the aerial part, fresh mass of the aerial part and the root, productivity, horizontal diameter and commercial classification of root, presence of white rings through notes and soluble solids content (ºBrix). Among the different genotypes studied, the cultivar Tall Top Early Wonder was superior in the variables of plant height, fresh mass of roots and leaves and soluble solids, 75 days after transplantation. The cultivar Tall Top Early Wonder responded better, implying the idea that organic fertilization would be an alternative as a source of nutrients in beet production.
Keywords: *Beta vulgaris* L., plant nutrition, plant development.

DESENVOLVIMENTO E PRODUTIVIDADE DE DOIS GENÓTIPOS DE BETERRABA EM FUNÇÃO DE ADUBAÇÃO

RESUMO - A beterraba necessita de uma grande demanda de nutrientes para que ocorram melhorias no seu desenvolvimento e produtividade. O objetivo deste trabalho foi avaliar o efeito de formas de adubação no desenvolvimento e produtividade da cultura de beterraba. O experimento foi conduzido na área experimental da Fazenda Escola do Centro de Ensino Superior dos Campos Gerais, localizado no município de Ponta Grossa-PR, entre setembro e novembro de 2018. O delineamento experimental foi de blocos casualizados em esquema fatorial 2x4 [2 genótipos de beterraba (híbrido Boro e a cultivar Tall Top Early Wonder) x 4 formas de adubação, sendo T1 - testemunha (sem adubação), T2 - cama de aviário, T3 - esterco bovino e T4 - NPK], contendo quatro repetições. A colheita foi realizada aos 75 dias após o transplante das mudas, colhendo cinco plantas de cada parcela para realização das análises, avaliando assim o número de folhas por planta, altura da parte aérea, massa fresca da parte aérea e da raiz, produtividade, diâmetro horizontal e classificação comercial de raiz, presença de anéis brancos por meio de notas e teor de sólidos solúveis (ºBrix). Entre os diferentes genótipos estudados, a cultivar Tall Top Early Wonder foi superior nas variáveis de altura de plantas, massa fresca de raízes e folhas e sólidos solúveis, 75 dias após o transplante. A cultivar Tall Top Early Wonder respondeu melhor, implicando na ideia de que a adubação orgânica seria uma alternativa como fonte de nutrientes na produção de beterraba.
Palavras-chave: *Beta vulgaris* L., nutrição vegetal, desenvolvimento vegetal.

INTRODUCTION

The *Beta vulgaris* L. species belongs to the Quenopodiaceae Family and can be divided into three groups: sugar beet production for sugar production, widely cultivated in Europe; beet used as fodder, which provides food for animals; and the best known in Brazil, table beet, in which the root of this plant is used in human food as vegetables (COSTA et al., 2017). Characterized as a vegetable of relevant importance in Brazil, beet adapts better in a temperate climate, containing an interesting nutritional value, as it presents high levels of potassium, sodium, iron, vitamin A and the B complex (SILVA et al., 2018).

The planting of this crop is greater in the southeastern and southern regions of Brazil, corresponding to approximately 42% of Brazilian production. Because of the high temperatures, which are negative factors for the production of this vegetable, the northeast region has less representation in the area cultivated for beet cultivation (FILGUEIRA, 2008).

The beet shows a marked growth until 80 days after sowing, and both the shoot and the root continue to

[1]Centro de Ensino Superior dos Campos Gerais (CESCAGE), Ponta Grossa, Paraná, Brasil. E-mail: danielmocelin@hotmail.com, flavio_sjbv@hotmail.com, gustavopmariano@hotmail.com. *Corresponding Author.

grow until the end of the cycle. The absorption of nutrients is continuous from 40 days from planting to harvest, with greater intensity from 60 days after transplantation, reaching an accumulation of 16.8; 12.1; 93.2; 6.1 and 88.0 kg ha^{-1} in the export of Mg, Ca, K, P and N from the soil, for a population 333,333 plant ha^{-1} and 30,000 kg ha^{-1} of productivity (GRANGEIRO et al., 2007).

In short periods of time, vegetables can have high yields, resulting in considerable exports of nutrients at the end of the harvest (SILVA et al., 2018). These crops generally need a large supply of nutrients in the time intervals of their cycle, considered relatively small. This need for nutrients in tuberous roots is essential for the development of the plant, both for its growth in the aerial part and for the root (BATISTA et al., 2016). The beet shows a marked growth until 80 days after sowing, being that both the aerial part and the root continue to grow until the end of the cycle. Nutrient absorption is continuous from 40 days from planting to harvest, with greater intensity from 60 days after transplantation, reaching an accumulation of 16.8; 12.1; 93.2; 6.1 and 88.0 kg ha^{-1} in the export of Mg, Ca, K, P and N from the soil, for a population 333,333 plant ha^{-1} and 30,000 kg ha^{-1} of productivity (GRANGEIRO et al., 2007).

Like other crops, beet is dependent on additional fertilization to be able to externalize its productive potential, since the amount of nutrients present in the soil is not able to supply the plant's nutritional demand. In this sense, it is extremely important to know the characteristics of the soil, availability of nutrients and nutritional needs of the crop so that the conscious application of fertilizers is carried out (LOPES et al., 2015).

Mineral fertilization is important in the final productivity of the plants and in the quality of the root, therefore, the use of a fertilizer in adequate levels is of great importance as to the correct supply of the content of each nutrient required by the crop (OLIVEIRA et al., 2016). The conventional way of supplying nutrients to beet culture has been through mineral fertilization, using chemical fertilizers. However, different fertilization alternatives have been sought due to the large expenses with mineral fertilizers, together with the problems of contamination of groundwater and soil (BATISTA et al., 2016).

According to Silva et al. (2018), there are few studies regarding alternative fertilizers for the cultivation of beet. In this context, organic agriculture today is inserted in a scenario of agricultural activity of greatest expansion in the world, joining the total and rational exploitation of the resources present in a property, with the lowest production cost (RAMALHO et al., 2016b). Sources of organic matter such as manure and biofertilizers are less aggressive to the environment and enable the development of agriculture that is less dependent on industrialized products, as well as the viability of the property for many years (DELEITO et al., 2005).

Organic agriculture is interesting due to the several benefits it provides, such as the accumulation of organic matter, contributing to the availability of nutrients that will act in the productivity indexes, improvement of the physical and chemical conditions of the soil, increase of the microbial diversity in the soil, among others. Given the above, the objective of this study was to evaluate the effect of poultry litter, cattle manure and chemical fertilization on the development and productivity of beet (*Beta vulgaris* L.).

MATERIAL AND METHODS

The experiment was conducted between September and November of the year 2019, in an experimental area of the Fazenda Escola Unit of the Higher Education Center of Campos Gerais (CESCAGE), located in the municipality of Ponta Grossa - PR, close to the BR-376 highway, km 503, under geographical coordinates: latitude 25º10’37.8”' South, longitude 50º06’51.16” West and altitude of 956.4m. According to the Köppen classification, the region’s climate is *Cfb* type, subtropical climate, with a well-distributed rainfall index throughout the year and moderate summers (SOUZA et al., 2013).

The soil in the experimental area is classified as LATOSSOLO VERMELHO, with its chemical analysis showing the values: pH = 6.00 mmolc dm^{-3}, MO = 28.62 g dm^{-3}, P (mehlich) = 18.51 mg dm^{-3}, K = 6.4 mmolc dm^{-3}, Ca = 42.70 mmolc dm^{-3}, Mg 18.80 = mmolc dm^{-3}, H + Al = 20.50 mmolc dm^{-3}, SB = 67.90 mmolc dm^{-3}, CTC = 97.40 mmolc dm^{-3}, V = 59.71%.

For the experiment, beet seedlings obtained from a commercial nursery of seedlings and vegetables in the city of Ponta Grossa - PR were used. The experimental design used was randomized blocks, in a 2x4 factorial scheme, containing four repetitions, the first factor consisting of two beet genotypes, the cultivar Tall Top Early Wonder and the hybrid Boro, and the second factor consisting of four different fertilizations, the treatments. T1 - Control (without fertilization), T2 - poultry litter (10 Mg ha^{-1}), T3 - bovine manure (20 Mg ha^{-1}) and T4 - basic fertilization with 1000 kg ha^{-1} of NPK (04-14-08) with cover fertilization at 30 days after transplantation with urea (70 kg ha^{-1}) in the formulation (45-00-00), with four repetitions in each treatment.

The experimental area was prepared with a rotary hoe, in a 38.4 x 1 m plot, divided into 32 1.2 m² (1.2 x 1 m) plots, the spacing used was 0.2 m between line and 0.1 m between plants, with each line of the plot consisting of 10 plants, using 0.2 m of border and 0.3 m of distance between plants of different plots. After application and incorporation of NPK, poultry litter and cattle manure, the transplant was performed manually on the same day of incorporation. Seven days after transplanting, the plants were thinned to ensure the desired plant population and correct spacing between seedlings.

The crop treatments consisted of weekly manual weeding, in order to keep the area free from invasive plant interference, and sprinkler irrigation, as the beet culture is very demanding in water throughout the productive cycle, moist soil conditions favor good root development (TIVELLI et al., 2011). The harvest was performed manually at 75 days after transplantation, harvesting 5 plants from the useful area in each plot, to carry out quantitative and qualitative analyzes. The analyzes performed were: number of leaves per plant (75 five days after transplant, coinciding with the harvest), height of the aerial part (cm), performed in two different seasons, the first at 28 days after transplant and the second on the day of harvest (75 days after transplant); fresh mass of aerial part and root (kg), root productivity (mg ha^{-1}), horizontal root diameter (cm) and its classification (scrap <5 cm, extra A between 5 and 9 cm and extra AA between 9 and 12 cm - TIVELLI et al., 2011). The presence of white rings was also evaluated by means of notes (1 = without ring, 2 = beginning of ring, 3 = with ring), receiving note 1 for roots with quality and without physiological disorder and note 3 for roots with quality weakened and presence of visible rings, transforming these data to square root of x + 1 and soluble solids content (ºBrix), preparing a solution obtained from the mixture of 5 roots of each plot, using a portable refractometer of the brand DIGT model 103 (PURQUERIO et al., 2009; MARQUES et al., 2010).

The results obtained were subjected to analysis of variance, with significance tested through the F test and comparison of means by the Tukey test, at 5% probability of error, with the aid of the R software (R CORE TEAM, 2020).

RESULTS AND DISCUSSION

Evaluating the statistical results, it was noted that for the plant height 28 days after transplantation, there was no interaction between the factors studied, neighter significant differences for the two genotypes and for the fertilization modes in analysis of the isolated effects of the factors, as shown in the Table 1. A similar result was found by Magro et al. (2015), who evaluated doses of commercial organic compound Provaso® and potassium cover fertilization in the Boron beet hybrid, where there was no effect of fertilization methods 28 days after transplantation on the vegetative characteristics of the plants. Corroborating with Jaeggi et al. (2014), who evaluated doses of organic compost based on bovine manure and garden pruning applied to the carrot culture, where the length of the aerial part of the plants was not greater than the control treatment.

According to Jaeggi et al. (2014), the low efficiency of organic fertilization may be related to the residual effect of fertilizations previously carried out in the same area, in addition to the fact that the cultivated crop does not show responsiveness to high doses of organic fertilizers.

TABLE 1 - Height of beet plants (cm) [cultivar Tall Top Early Wonder (TTEW) and Boron hybrid], 28 and 75 days after transplanting the seedlings, with different forms of fertilization.

Genotypes	28 days after transplantation			
	Forms of fertization			
	Without fertilization	Poultry litter	Bovine manure	NPK
Cultivar TTEW	10,06 Aa*	11,35 Aa	9,93 Aa	12,57 Aa
Boron Hybrid	18,18 Aa	13,22 Aa	10,14 Aa	12,92 Aa
CV (%)	39,84			
	75 days after transplantation			
Cultivar TTEW	46,75 ABa	49,85 Aa	46,70 Aba	44,40 Ba
Boron Hybrid	35,68 Bb	43,40 Ab	40,60 ABb	42,00 Aa
CV (%)	5,82			

*Means followed by equal lowercase letters in columns and uppercase letters in rows do not differ by Tukey's test (p<0,05).

In a study of fertilization with bovine manure for the cultivar TTEW of beet, it is possible to observe a linear increase in the aerial part, according to the increase in doses up to 80 mg ha^{-1} (MARQUES et al., 2010). The lack of responsiveness of the different genotypes studied in the current experiment when fertilized with bovine manure (20 mg ha^{-1}), may be related to the low dose of application of this fertilizer when compared to the applied dose.

For plant height 75 days after transplantation, there was interaction between the two genotypes and the forms of fertilization, where the cultivar TTEW responded better in treatments T1, T2 and T3 than the hybrid Boro, reaching 49.85 centimeters when the bed of poultry was applied (T2), although no statistical differences were observed for fertilization with NPK (T4). Analyzing the isolated effect of the fertilization forms in the two beet genotypes, it is observed that there were significant differences between T2 and T4 for the TTEW cultivar, and between T1 and T2, for the Boro hybrid, in both the application of poultry litter was observed. higher.

Similar results were observed by Salles et al. (2017), where organic fertilization with poultry litter applied alone or in combination with bovine manure or filter cake, promoted greater height of arugula plants, also increasing the number of leaves per plant and the fresh and dry matter of the aerial part the same. For Ramalho et al. (2016a), the cultivar Crimson Gigante de radish reacted better to green manure up to the dose of 30 mg ha-1 of dry matter incorporated in the soil, obtaining a linear growth of its height from the aerial part, as the doses of green manure increased. According to Souza and Resende (2006), among organic fertilizers, poultry manure contains higher percentages of NPK when compared to swine and bovine manure, since birds deject urine together with feces, favoring the supply of nitrogen for the fertilizer. The organic fertilizer from poultry manure can also be compared to urea due to the high nutrient content and the rapid response of the crops.

The number of leaves per plant resulted in a greater presence of the plant structure for the Boro hybrid compared to cultivating TTEW in all treatments, as shown in Table 2, but not statistically differing when comparing the forms of fertilization for the two genotypes, indicating that there was no interaction between the factors evaluated. This result was similar to that found by Ribeiro Júnior et al. (2017), who evaluated different organic and mineral fertilizers in the fertilization of *Brachiaria brizantha* cv. Marandú, where the number of leaves did not differ between treatments with organic compounds of bovine manure, poultry and sheep, besides the mineral fertilization with urea and NPK in the formulation 30-00-10.

TABLE 2 - Number of beet leaves [cultivar Tall Top Early Wonder (TTEW) and hybrid Boron], 75 days after transplanting the seedlings, with different forms of fertilization.

Genotypes	75 days after tranplantation			
	Forms of fertilization			
	Without fertilization	Poultry litter	Bovine manure	NPK
Cultivar TTEW	12,25 Ab*	12,35 Ab	12,25 Ab	13,80 Ab
Boron Hybrid	15,05 Aa	13,50 Aa	15,05 Aa	15,20 Aa
CV (%)	8,35			

*Means followed by equal lowercase letters in the columns and uppercase letters in the lines do not differ from each other by the Tukey test ($p < 0.05$).

Melo et al. (2014), studying the fertilization in coverage with bovine manure and amounts of carnauba straw in the soil cover, for the giant Crimson radish cultivar, pointed out that with the increase in the doses of bovine manure and the carnauba straw, there was an increase linear order for the number of leaves per plant as the doses increased up to 18 mg ha^{-1} of carnauba straw + 18 mg ha^{-1} of cattle manure. In the present study, both the TTEW cultivar and the Boro hybrid showed an average value of 12.66 and 14.7 leaves per plant at 75 days after transplant, respectively, among the different forms of fertilization used. This helps in the choice of the cultivar depending on its use, where, the Boro hybrid would be interesting for the production aiming at the commercialization of the leaves of the plant, for producing a greater value of these vegetal structures, for example.

The horizontal diameter of the roots did not vary significantly between forms of fertilization, however the Boro hybrid was superior to cultivating TTEW in all treatments, being on average 0.55 cm, reinforcing the idea that the use of higher doses of organic fertilizers could bring different results (Table 3). Oliveira et al. (2019), evaluating different forms of organic fertilization on beet, explained that for the longitudinal and transversal diameters of the root, the treatment with biofertilizer prepared with bovine manure was not distinguished from the control that was composed by mineral fertilization.

TABLE 3 - Root diameter (cm) of beet plants [cultivar Tall Top Early Wonder (TTEW) and Boron hybrid], 75 days after transplanting the seedlings, with different forms of fertilization.

Genotypes	75 days after transplantation			
	Forms of fertilization			
	Without fertilization	Poultry litter	Bovine manure	NPK
Cultivar TTEW	5,92 Ab*	6,04 Ab	5,49 Ab	5,80 Ab
Boron Hybrid	6,10 Aa	6,56 Aa	6,30 Aa	6,49 Aa
CV (%)	6,94			

*Means followed by the same lowercase letters in the columns and uppercase letters in the lines do not differ by Tukey's test ($p < 0.05$).

Following the same ideology, working with the Boron hybrid of beet and fertilizing with different doses of the organic compound Provaso® and top dressing with potassium (K), Magro et al. (2015) stated that the root diameter did not show any discrepancy between the application or not of K in coverage, as well as other fertilizations. However, the same authors report an increase in the diameter of the roots up to the dose of 48 mg ha^{-1} of organic compound, with a decrease in the values from that dose.

According to Tivelli et al. (2011), the roots fit the extra commercial diameter A (between 5 and 9 cm) in all treatments and in the two genotypes, showing that organic fertilization equals chemical and can be used in the production of beets with sizes acceptable to the market. The classification of the root in this parameter is of great importance when marketing beet, as it brings greater profitability to the producer, since the larger the size, the higher the price of the crop's kg (WATTHIER et al., 2016). According to Silva et al. (2018), the production of vegetables in organic systems has frequently increased, including beet. In their work with this crop and top dressing with Bokashi (organic compost) they pointed out that the use of organic compost favors the production of beets of extra commercial diameter A and that chemical and organic fertilization when in consortium benefit the crop even more.

There was no interaction between the factors evaluated in this study for the fresh root mass analyzed at 75 days after transplanting the beet seedlings, which did not differ statistically between themselves for fertilization methods, nor for the two genotypes evaluated as shown in Table 4. Close results with the present study were found by Silva et al. (2016), who pointed to a non-significant effect of the association of fertilizers with different doses of castor bean cake, with inorganic NPK fertilization compared to the control, for the productivity variable.

In the fresh weight of the leaves, the results followed the same patterns as the fresh weight of the root, differing only in the difference between the genotypes, where the cultivar TTEW was better than the hybrid Boron in all treatments (Table 4). Sediyama et al. (2011), verified different types of soil cover, productivity and export of nutrients in the cultivation of beet. Such authors indicated that the coffee straw increased the fresh mass of the aerial part of beet plants, reaching 102.9 g plant^{-1}, when compared to coverings with sugarcane bagasse (84.59 g plant^{-1}) and without cover soil (80.89 g plant^{-1}).

TABLE 4 - Fresh root mass (kg) and fresh leaf mass (kg) of beet plants [cultivar Tall Top Early Wonder (TTEW) and hybrid Boron], 75 days after transplanting the seedlings, with different forms of fertilization.

Genotyps	Fresh root mass (kg)			
	Forms of fertilization			
	Without fertilization	Poultry litter	Bovine manure	NPK
Cultivar TTEW	0,1200 Aa*	0,1520 Aa	0,1020 Aa	0,1256 Aa
Boron Hybrid	0,1067 Aa	0,1129 Aa	0,1373 Aa	0,1230 Aa
CV (%)	22,15			
	Fresh leaf mass (kg)			
Cultivar TTEW	0,1366 Aa	0,1533 Aa	0,1501 Aa	0,1513 Aa
Boron Hybrid	0,0835 Ab	0,1177 Ab	0,1083 Ab	0,1241 Ab
CV (%)	24,93			

*Means followed by equal lowercase letters in the columns and uppercase letters in the lines do not differ from each other by the Tukey test (p<0,05).

Table 5 shows the productivity values of the beet roots, with no interaction between the two genotypes studied and the forms of fertilization. A similar result was found by Oliveira et al. (2019), where the forms of organic fertilizer studied did not show statistical differences between them for productivity, however the average productivity found for these authors was 24.43 mg ha^{-1}, being below the values determined in the present study that fluctuated between 33.9866 to 50.6783 mg ha^{-1}, among treatments and genotypes, a value that exceeded the average productivity of the state of Paraná in 2016, which was approximately 29.5 mg ha^{-1} (DERAL, 2017).

TABLE 5 - Yield (mg ha^{-1}) of beet roots [cultivar Tall Top Early Wonder (TTEW) and hybrid Boron], 75 days after transplanting the seedlings, with different forms of fertilization.

Genotypes	75 days after transplantation			
	Forms of fertilization			
	Without fertilization	Poultry litter	Bovine manure	NPK
Cultivar TTEW	39,985 Aa*	50,6783 Aa	33,9866 Aa	41,855 Aa
Boron Hybrid	35,550 Aa	37,6216 Aa	45,7716 Aa	41,012 Aa
CV (%)	22,15			

*Means followed by equal lowercase letters in columns and uppercase letters in rows do not differ by Tukey’s test (p<0,05).

For Marques et al. (2010), fertilization with bovine manure showed a linear growth in the productivity of beet, according to the increase in the doses of organic compost. This is explained, as the applied doses of cattle manure and poultry litter may have been low and did not show much representativeness in the culture productivity. Unlike what was exposed in this work, Coutinho et al. (2018) cited that beet cultivars can reach more than 100 mg ha^{-1}, when fertilized with NPK and boron, as was the case of the TTEW cultivar that reached 105.53 mg ha^{-1}.

High incidence of rain combined with hot temperatures (25°C and 30°C) favor the development of diseases and physiological anomalies in beet, such as the appearance of white rings (PUIATTI; FINGER, 2005). These rings lower the price when the crop is commercialized, as it is a characteristic that does not please the wholesale market and depending on the level of occurrence, the harvest can be stopped (PURQUERIO et al., 2009). Thus, it is important to work with fertilizers and genotypes that favor the low incidence of this anomaly.

According to Tullio et al. (2013), the cultivars TTEW and Itapuã 202, did not present white rings when cultivated in a natural environment, under an average temperature of 24.6°C and in a protected environment with an average temperature of 22.1°C.

In the present study, there were no significant differences between the forms of fertilization, however the Boro hybrid had lower grades for the presence of white rings (closer to note 1, corresponds to roots without the presence of white rings) than the cultivar TTEW, denoting better root quality under experimental conditions (Table 6). Silva et al. (2019), pointed out data that reaffirm the results found in the present study with respect to the difference between genotypes, since, in its work on phosphate fertilization in beet cultivars, the cultivar Cabernet expressed lower notes for the presence of rings white when compared to cultivars, Early Wonder, Kestrel and Fortuna.

Table 7 shows that the cultivar TTEW was superior in the content of soluble solids per plant, in relation to the Boro hybrid, indicating a distinction in root quality between these genotypes, but without statistical differences between fertilizations. For Marques et al. (2010), the fertilization doses with bovine manure up to 80 mg ha^{-1} did not alter the soluble solids of the beet roots, following the same logic of the results found for the present study. Dutra et al. (2016), found that, for the melancholy cv. Crimson sweet the basic organic fertilization with bovine manure, goat manure and earthworm humus did not alter the levels of soluble solids in the fruits produced. In contrast, these authors mention that the application of biofertilizer based on bovine manure in coverage, from the dose of 68.5 mL plant^{-1}, changes the chemical quality of watermelon fruits, reducing the levels of soluble solids.

TABLE 6 - Notes of the presence of white rings on the beet roots [cultivar Tall Top Early Wonder (TTEW) and Boron hybrid], 75 days after transplanting the seedlings, with different forms of fertilization.

Genotypes	75 days after transplantation			
	Forms of fertilization			
	Without fertilization	Poultry litter	Bovine manure	NPK
Cultivar TTEW	1,76 Aa*	1,76 Aa	1,79 Aa	1,79 Aa
Boron Hyrid	1,56 Ab	1,64 Ab	1,60 Ab	1,60 Ab
CV (%)	5,14			

*Means followed by equal lowercase letters in the columns and uppercase letters in the lines do not differ from each other by the Tukey test (p<0,05).

TABLE 7 - Soluble solids (°Brix) of beet roots [Tall Top Early Wonder cultivar (TTEW) and Boro hybrid], 75 days after transplanting the seedlings, with different forms of fertilization.

Genotypes	75 days after transplantation			
	Forms of fertilization			
	Without fertilization	Poultry litter	Bovine manure	NPK
Cultivar TTEW	7,45 Aa*	7,23 Aa	7,75 Aa	7,28 Aa
Boron Hyrid	7,20 Ab	6,10 Ab	6,23 Ab	5,98 Ab
CV (%)	13,57			

*Means followed by equal lowercase letters in the columns and uppercase letters in the lines do not differ from each other by the Tukey test (p<0,05).

The determination of the content of soluble solids is an indicator of maturation used by the Brazilian Program for the Modernization of Horticulture (PBMH), where fruit trees to present acceptable levels of compounds responsible for their organoleptic characteristics, aroma and flavor, it is necessary that their content of soluble solids are adequate, on the contrary, serious defects are characterized when harvesting immature fruits, losing quality and decreasing price at the time of sale (CEAGESP, 2016). This is no different for beet, which also favors the production of sugar industries when the roots have higher levels of soluble solids.

The data for the form of fertilization being mineral, with cattle manure or poultry litter, and without fertilization did not vary statistically for plant height 28 days after transplant, number of leaves, diameter of roots, fresh weight of leaves and roots, white rings and soluble solids, the latter six being evaluated 75 days after transplantation. This demonstrates that the fertilization being the same, choosing the one that brings the greatest benefits not only for beet cultivation would be the most interesting for agricultural production. According to Higashikawa; Menezes Júnior (2017), organic fertilization is able to provide subsidy for onion development, as well as chemical fertilization, because the comparison between the two fertilization methods did not significantly differentiate productivity, on the other hand, organic fertilization brought improvements for the physicochemical properties of the soil.

Magro et al. (2015), found in their study that although organic fertilization does not bring differences for the development of beet, it allows the improvement of soil chemical conditions such as pH, calcium content, sum of bases and base saturation. This can benefit the subsequent crops that will be worked in the same area. According to Rós et al. (2014), organic fertilization with chicken manure can bring greater total and commercial productivity for the cultivation of sweet potatoes, and may even replace mineral fertilization with NPK, since the application of bovine manure in doses. For Pinto et al. (2004), the weight of beet roots with organic fertilization was equivalent to chemical fertilization, which gives the idea that the producer can only use organic fertilization for this crop, demonstrating that alternative fertilizations may be viable for the future of agriculture.

Among the different genotypes studied, Tall Top Early Wonder cultivar was superior for plant height, fresh mass of roots and leaves and soluble solids, 75 days after transplantation. The Boro hybrid responded better in the characteristics of the number of leaves and notes of presence of white rings 75 days after transplantation. In a study by Coutinho et al. (2018), there was a difference in leaf numbers, ratio, titratable acidity and anthocyanins among beet cultivars in different cultivation systems. This result demonstrates that there may be genetic differences between cultivars, which may show improvements or deficits in the development and quality of beet.

Marques et al. (2010), mention that the chemical characteristics of beet differ depending on the variety, nutrition, climatic conditions, maturation stage, among other characteristics. In their research, Silva et al. (2019) determined that the cultivar Cabernet and Kestrel were more responsive than the cultivar Early Wonder and Fortuna to potassium fertilization in the dry leaf mass. In this context, the results mentioned above can be related to the two genotypes analyzed in the present study, where they showed differences between them, reaffirming that the genetic variability is totally interconnected with the plant's response to different agricultural practices that were carried out during its cycle.

CONCLUSION

Among the different genotypes studied, the cultivar Tall Top Early Wonder was superior in the variables of plant height, fresh mass of roots and leaves and soluble solids, 75 days after transplantation.

The cultivar Tall Top Early Wonder responded better, implying the idea that organic fertilization would be an alternative as a source of nutrients in the production of beet.

REFERENCES

BATISTA, M.A.V. Atributos de solo-planta e de produção de beterraba influenciados pela adubação com espécies da Caatinga. **Horticultura Brasileira**, v.34, n.1, p.31-38, 2016.

CEAGESP. COMPANHIA DE ENTREPOSTOS E ARMAZÉNS GERAIS DE SÃO PAULO. A medida da doçura das frutas. São Paulo: Centro de qualidade, pesquisa e desenvolvimento. **Cartilha Técnica, n.8**. 17p. 2016.

COSTA, F.A.; NASCIMENTO, W.M.; SILVA, P.P. Indução floral de beterraba por meio de vernalização artificial das raízes nas condições de Brasília. **Savannah Journal of Research and Development**, v.1, n.1, p.28-33, 2017.

COUTINHO, P.W.R.; ECHER, M.M.; OLIVEIRA, P.S.; DALASTRA, G.M.; CADORIN, D.A.; VANELLI, J. Productivity and qualitative characteristics of varieties of beets. **Journal of Agricultural Science**, v.10, n.6, p.327-333, 2018.

DELEITO, C.S.R.; CARMO, G.F.; FERNANDES, M.C.A; ABBOUD, A.C.S. Ação do biofertilizante Agrobio sobre a mancha-bacteriana e desenvolvimento de mudas de pimentão. **Horticultura Brasileira**, v.23, n.1, p.117-122, 2005.

DUTRA, K.O.G.; CAVALCANTE, S.N.; VIEIRA, I.G.S.; COSTA, J.C.F.; ANDRADE, R. A adubação orgânica no cultivo da melancieira cv. Crimson Sweet. **Revista Brasileira de Agropecuária Sustentável**, v.6, n.1, p.34-45, 2016.

FILGUEIRA, F.A.R. **Novo manual de olericultura:** agrotecnologia moderna na produção e comercialização de hortaliças. 3a. ed. Viçosa: UFV, 2008. 421p.

GRANGEIRO, L.C.; NEGREIROS, M.Z.D.; SOUZA, B.S.D.; AZEVÊDO, P.E.D.; OLIVEIRA, S.L.D.; MEDEIROS, M.A.D. Acúmulo e exportação de nutrientes em beterraba. **Ciência e Agrotecnologia**, v.31, n.2, p.267-273, 2007.

HIGASHIKAWA, F.S.; MENEZES JÚNIOR, F.O.G. Adubação mineral, orgânica e organomineral: efeitos na nutrição, produtividade, pós-colheita da cebola e na fertilidade do solo. **Scientia agraria**, v.18, n.2, p.1-10, 2017.

JAEGGI, M.E.P.C.; SALUCI, J.C.G.; COELHO, P.H.P.; ALVAREZ, C.R.S.; CARVALHO, A.H.O.; LIMA, L.W. Adubação orgânica no desenvolvimento e produção de cenoura. **Cadernos de Agroecologia**, v.9, n.4, p.1-11, 2014.

LOPES, S.G.; SILVA, C.A.; LOPES, F.A.S.; FERREIRA, M.M.; REIS, L.L. Manejos de irrigação e doses de nitrogênio em beterraba. **Revista Agrogeoambiental**, v.8, n.3, p.25-39, 2015.

MAGRO, F.O.; SILVA, E.G.; TAKATA, W.H.S.; CARDOSO, A.I.I.; FERNANDES, D.M.; EVANGELISTA, R.M. Organic compost and potassium top dressing fertilization on production and quality of beetroot. **Australian Journal of Crop Science**, v.9, n.10, p.962, 2015.

MARQUES, L.F.; MEDEIROS, D.C.D.; COUTINHO, O.D.L.; MARQUES, L.F.; MEDEIROS, C.D.B.; VALE; L.S.D. Produção e qualidade da beterraba em função da adubação com esterco bovino. **Revista Brasileira de Agroecologia**, v.5, n.1, p.24-31, 2010.

MELO, F.N.B.; LINHARES, P.C.F.; SILVA, E.B.R.; NEGREIROS, A.M.P.; NETO, J.B.D. Desempenho produtivo do rabanete sob diferentes quantidades de palha de carnaúba mais esterco bovino em cobertura. **Agropecuária Científica no Semiárido**, v.10, n.3, p.53-59, 2014.

OLIVEIRA, D.J.L.S.F.; PEREIRA, D.B.; NASCIMENTO, B.E.L.; MELO FILHO, L.C. Combinações de diferentes fontes de adubos orgânicos no cultivo da beterraba em Colorado do Oeste - Rondônia. **Ciências Agrárias:** Campo Promissor em Pesquisa, n.2, v.2, p.69-75, 2019.

DERAL. DEPARTAMENTO DE ECONOMIA RURAL DA SEAB. Secretaria de Estado da Agricultura e do Abastecimento do Estado do Paraná. **Olericultura -** Análise da conjuntura agropecuária. Curitiba: Deral, 2017. 18p. Disponível em:<http://www.agricultura.pr.gov.br/arquivos/File-/deral/Prognosticos/2018/Olericultura_2017_18.pdf>. Acesso em: 22 mai. 2019.

OLIVEIRA, R.J.; GATIBONI, L.C.; VALICHESKI, R.R.; MIQUELLUTI, D.J.; BRUNETTO, G. Calibração da adubação fosfatada e potássica para beterraba na região do Vale do Itajaí. **Horticultura Brasileira**, v.34, n.2, p.210-215, 2016.

PINTO, J.M.; PINTO, A.R. TEIXEIRA, V.A. Comportamento da beterraba (*Beta vulgaris*) cultivada em diferentes regimes de adubação. **Horticultura Brasileira**, v.22, n.2, p.410-414, 2004.

PUIATTI, M.; FINGER, F.L. Cultura da beterraba. In: FONTES, P.C.R. (Ed.). **Olericultura:** teoria e prática. Viçosa: Suprema, 1a. ed. 2005. p.345-354.

PURQUERIO, L.F.V.; FACTOR, T.L.; LIMA JÚNIOR, S.; TIVELLI, S.W.; TRANI, P.E.; BREDA JÚNIOR, J.M.; ROCHA, M. Produtividade e qualidade de beterraba cultivada em plantio direto em função do nitrogênio e molibdênio. **Horticultura Brasileira**, v.2, n.27, p.366-372, 2009.

RAMALHO, W.B.; LINHARES, P.C.F.; ASSIS, J.P.; ALMEIDA, A.M.B.; CUNHA, L.M.M. Adubação verde com espécies espontâneas da caatinga no cultivo do rabanete em sucessão a rúcula. **Revista Verde de Agroecologia e Desenvolvimento Sustentável**, v.11, n.2, p.66-70, 2016a.

RAMALHO, W.B.; LINHARES, P.C.F.; MARACAJÁ, P.B.; ALMEIDA, A.M.B.; MORAIS, A.P. Desempenho econômico do consórcio de coentro com beterraba, adubados com doses de jitirana, combinada com esterco bovino. **Revista Verde de Agroecologia e Desenvolvimento Sustentável**, v.11, n.1, p.78-83, 2016b.

R CORE TEAM (2020). **R:** A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Áustria. Disponível em: <http://www.R-project.org>. Acesso em: 11 jan. 2020

RIBEIRO JÚNIOR, M.R.; CANAVER, A.B.; RODRIGUES, A.B.; DOMINGUES NETO, F.J.; SPERS, R.C. Desenvolvimento de Brachiaria brizantha cv. Marandu submetidas a diferentes tipos de adubação (Química e Orgânica). **Revista Unimar Ciências**, v.24, n.1-2, p.49-53, 2017.

RÓS, A.B.; NARITA, N.; HIRATA, A.C.S. Produtividade de batata-doce e propriedades físicas e químicas de solo em função de adubação orgânica e mineral. **Semina:** Ciências Agrárias, v.35, n.1, p.205-214, 2014.

SALLES, J.S.; STEINER, F.; ABAKER, J.E.P.; FERREIRA, T.S.; MARTINS, G.L.M. Resposta da rúcula à adubação orgânica com diferentes compostos orgânicos. **Journal of Neotropical Agriculture**, v.4, n.2, p.35-40, 2017.

SEDIYAMA, M.A.; SANTOS, M.R.; VIDIGAL, S.M.; SALGADO, L.T. Produtividade e exportação de nutrientes em beterraba cultivada com cobertura morta e adubação orgânica. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v.15, n.9, p.883-889, 2011.

SILVA, P.N.L.; LANNA, N.B.L.; CARDOSO, A.I.I. Doses de bokashi em cobertura na produção de beterraba. **Journal of Neotropical Agriculture**, v.5, n.1, p.28-34, 2018.

SILVA, G.A.; GRANGEIRO, L.C.; SOUSA, V.F.L.; SILVA, L.R.R.; JESUS, P.M.M.; SILVA, J.L.A. Desempenho agronômico de cultivares de beterraba em função da fertilização com fósforo. **Revista Brasileira de Engenharia Agrícola e Ambiental**, Campina Grande, v.23, n.7, p.518-523, 2019.

SILVA, P.N.L.; LANNA, N.B.L.; CARDOSO, A.I.I. Produção de beterraba em função de doses de torta de mamona em cobertura. **Horticultura Brasileira**, v.34, n.3, p.416-421, 2016.

SOUZA, J.L.; RESENDE, P. **Cultivo orgânico de hortaliças.** Manual de horticultura orgânica. 2a. ed. Atualizada e ampliada. Viçosa, Minas Gerais: Aprenda Fácil. 2006.

SOUZA, J.L.M.; GERSTEMBERGER, E.; ARAUJO, M.A. Calibração de modelos agrometeorológicos para estimar a produtividade da cultura do trigo, considerando sistemas de manejo do solo, em Ponta Grossa-PR. **Revista Brasileira de Meteorologia**, v.28, n.4, p.409-418, 2013.

TIVELLI, S.W.; FACTOR, T.L.; TERAMOTO, J.R.S.; FABRI, E.G.; MORAES, A.D.; TRANI, P.E.; MAY, A. **Beterraba:** do plantio a comercialização. Campinas: Instituto Agronômico de Campinas, 2011. 45p. (Série Tecnologia APTA. Boletim Técnico IAC, 210).

TULLIO, J.A.; OTTO, R.F.; BOER, A.; OHSE, S. Cultivo de beterraba em ambientes protegido e natural na época de verão. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v.17, n.10, p.1074-1079, 2013.

WATTHIER, M.; SILVA, M.A.S.; SCHWENGBER, J.E.; FONSECA, F.D.; NORMBERG, A. Produção de mudas e cultivo a campo de beterraba em sistema orgânico de produção. **Revista Brasileira de Agropecuária Sustentável**, v.6, n.2, p.51-57, 2016.