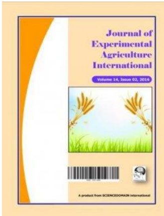

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Post Harvest Quality of Bt Green Maize Produced in Different Water Harvesting Techniques with the Application of Rooting

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Authors' contributions

This work was carried out in collaboration between all authors. Author AMN elaborated the study, participated in all the steps of conducting and writing the manuscript. Author FBC consists of the research supervisor, showed the alternatives of conducting and evaluating the data, assisted in the statistical part of the work. Author JLS decisive in the correction phase, showed the alternatives to enrich the information work. Author MEBB consists of the supervisor of the experiment in field assisting in the production of corn. Author TMG participated during writing assisting to enrich the work. Authors LJGF and LAS participated in the process of planning and conducting the experiment in the field. Authors AFS and KGS were of paramount importance in the conduction and evaluation of the experiment. Authors MSS and LSS participated during the physical and chemical evaluations in the laboratory after harvesting. All authors read and approved the final manuscript.

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ABSTRACT

Objective: The objective of this work was to evaluate the characteristics of Bt green maize produced in different water harvesting techniques using two concentrations of commercial rooting.
Experimental Design: The experiment was conducted in a completely randomized design using the 2x3 factorial scheme. In the first factor, two levels of the Avant® rooting were tested, based on the manufacturer's recommendation, ie 0 and 125%. The second factor corresponds to three techniques of soil preparation, being: basins (B), ridges (C) and grooves (S).
Place and Duration of the Study: The experiment was conducted from July to September in the experimental area of the Center of Science and Technology Agrifood of the Federal University of Campina Grande, Campus of Pombal, Paraíba, Brasil.
Methodology: The spikes were selected for ten replicates and were analyzed with straw, then manually depleted for physical analysis. After the removal of the straws, the grains were cut with the help of a stainless steel knife and crushed in a blender for chemical analysis.
Results: The interaction between the different techniques of water uptake and rooting levels had a significant effect on the variables: fresh mass of straw with no straw, length, basal diameter, number of grains, electrolyte extravasation, flavonoids and phenolic compounds, where the catchment systems of basin and roosts with rooting proved to be more efficient.
Conclusion: The techniques of catchment basin and rows with rooting obtained better characteristics in the spikes, indicating that the roots of the plants in these systems reached a greater amount of water in the soil.

Keywords: Zea mays L.; cultivation; spikes; root.

1. INTRODUCTION

Maize (*Zea mays L.*) is a species belonging to the Gramineae/Poaceae family that originated in Central America for more than 8000 years and is cultivated in many parts of the world due to its great adaptability represented by varied genotypes. It is a plant with important purposes in human and animal food due to its high nutritional qualities [1].

In Brazil the exploitation of corn for the production of green maize is an important agricultural activity, especially in the northeast region, because green maize is a product of good acceptance and high value-added, compared to the one destined for production of dry grains, thus becoming a viable alternative, especially for small producers who harvest the ears with the moisture content of the grains between 70 and 80% to be consumed in natural or in the form of several dishes, or even industrialized and marketed in the form of canned green corn [2,3].

Green corn cobs are considered to be highly perishable because they are still immature, which means that they are dehydrated after harvesting, which leads to loss of mass, making it necessary for the producer to be quick to commercialize, or employing techniques to reduce the metabolic activity of enzymes, contributed to the retardation of maturation and loss of water, maintaining the desired qualities of the product as: flavor, color, texture and odor [4]. In this sense, it is important to know the physical, physical-chemical attributes and chemical composition of green maize as a way of understanding the transformations that alter the final quality of this product [5].

There are several studies in the attempt to obtain cultivars with the characteristics necessary for commercialization, such as plants with long and cylindrical spikes, well stuffed, clear sabots, uniform grains, toothed type, yellow color and soft pericarp, besides remaining longer in the field on green corn point. These studies, together with works that seek better cultural management and understand the effects of edaphoclimatic conditions on maize cultivars, are of great relevance for producers to know which cultivars are best and can employ the appropriate management techniques [2,6].

A well developed root system in the plant along with good irrigation and nutrition are also of great importance for the development of a quality green corn, since the roots provide all support to the plant by absorbing translocating water and mineral salts from the soil, thus producers use rooting to stimulate the development of roots in plants and consequently increase productivity [7,8]. The objective of this work was to evaluate the characteristics of Bt green maize produced in different water harvesting techniques using two concentrations of commercial rooting.

2. MATERIALS AND METHODS

The experiment was carried out in an experimental area of the Agrifood Science and Technology Center - CCTA, Federal University of Campina Grande - UFCG, located in the municipality of Pombal, PB (6º47'20 "S and 37º48'01" W longitude and altitude of 194 m). The region has a warm and dry climate, with an annual average rainfall of 750 mm and average annual evaporation of 2000 mm in the semi-arid regions [9]. Regarding climatic aspects during the experimental period, the average maximum and minimum temperatures were 21 and 20°C, respectively, of the relative humidity of the air 78% and the rainfall was 50 mm, obtained by the reading of an installed rain gauge in the field.

The experimental design was completely randomized using the 2x3 factorial scheme. In the first factor, two levels of the Avant® rooting were tested, based on the manufacturer's recommendation, that is, 0 and 125%. The second factor corresponds to three techniques of soil preparation, being: basins (B), ridges (C) and grooves (S).

2.1 Plant Material and Experience Management

For conventional planting, seeds of the 'Bt' hybrid of Agroceres were used in an area of 2x3 m. The soil was plowed and grated for complete discharging and leveling, not containing soil and water containment structure, that is, sowing was carried out in the soil submitted only to the railing. Subsequently, a sample was collected at depth of 0-20 cm, which was referred for fertility analysis for nutritional management purposes as suggested by Borgonovit et al. [10], thus guaranteeing the fertility conditions necessary for the growth of corn crop in the plantation area. The experiment was carried out in the dry season and there was a limitation in the rainfall conditions, so a weekly irrigation was carried out by sprinkling, applying a slide equivalent to the reference evapotranspiration of the week, calculated by the Penman-Monteith method - FAO [11].

The soil was plowed and meshed for complete discharging and leveling. After soil preparation, in situ water abstraction techniques were implemented: Basins: they were manually made by building small dams around each linear meter of plants, generating catchment areas of 1 m^2. The soil for the construction of the dam was removed from the cultivation area following the contours of the terrain. Camalhões: they were allocated in an intercalary way to the furrows, in this way at the distance was also of 0.9 m, its confection was done manually, making mounds with a height of 0.4 m and length of 4 m in the plot. Furrows: Manually made with a hoe, they had, in each plot, compliance of 4 m, being closed at their ends, following the ground level curves, which were allocated using a hose level (Leveling with water inside a clear hose), the distance between grooves shall be 0.9 m.

Harvesting of green corn ears was performed at 7 o'clock in the morning at the reproductive stage between R3 with grains and R4 with milky grains. Grain development stages occurred 18 to 28 days after the doping [12]. Soon afterward it was transported in plastic bags for the Laboratory of Chemistry, Biochemistry and Food Analysis.

2.2 Physical Characterization of Maize

The spikes were selected in 10 replicates per plot and analyzed with straw, then the straw was removed manually to proceed to the physical analyzes.

- The fresh mass of the cobs: A with straw was estimated in grams, by weighing in a precision scale with 4 decimal places. The straw was then removed and weighed again, the grains were later removed and weighed beans and cob weighed separately.

- Length and diameter of the spikes: Digital caliper was used. In the length, the whole extension of the spike was considered already naked, for the diameter the basal, average and apical positions were evaluated. The number of rows and grains per ear was estimated by manual counting.

- Extravasation of electrolytes: The methodology described by Simon [13] was used, with adaptations. The green corn grains were selected, weighed individually and transferred to an erlenmeyer containing 50 mL of distilled water. The initial reading of electrolyte extravasation was verified by means of a benchtop conductivity meter (mCA 150). Immediately after the samples were taken for continuous stirring on a mechanical shaker (Shaker) for a period of two hours. After shaking the samples were submitted to 5 sessions of 2 minutes in a microwave oven (Electrolux - 31 L). After the sections were finished reading the electrolyte extravasation.

2.3 Chemical Analyzes of Maize

After removal of the straws, the grains were cut with a stainless steel knife and ground in a blender for analysis.

- Soluble solids: 2 g of the sample was then morphed into cotton and an amount sufficient to cover the reading lens was dripped onto the refractometer. The apparatus used was the digital portable bench refractometer at automatic … an automatic temperature at 25°C.

- Hydrogen ionic potential: was determined with the samples directly in digital bench potentiometer model (DM-22).

- Titratable acidity: It was estimated according to the Analytical standards of the Adolfo Lutz Institute [14]. The sample was weighed, transferred to the erlenmeyer flask, filled with 50 ml of distilled water and 2 drops of phenolphthalein, then titrated against the 0.1 M sodium hydroxide solution. The results were expressed as percent acid malic by fruit. The ascorbic acid contents were determined according to the Analytical standards of the Adolfo Lutz Institute [14]. The samples were weighed, transferred to the erlenmeyer flask and quenched with 50 mL of chilled 0.5% oxalic acid. Then he braced himself against the Tillmans solution to the turning point. The results were expressed as mg/100 g of ascorbic acid.

- Flavonoids: The Francis method was used [15]. Samples were weighed and macerated in a mortar along with 5 mL ethanol-HCl. Shortly thereafter, the extract was transferred to a falcon tube and the volume was filled to 10 mL. It was left in the refrigerator for 24 hours and the next day it was centrifuged for 10 minutes at 10°C and 3000 rpm. An aliquot was taken in a cuvette and made as spectrophotometer readings at absorbances of 374 nm.

- Phenolic compounds: was carried out following the method of Waterhouse [16]. Samples were first weighed, macerated and diluted in 50 mL of distilled water, then allowed to stand for 30 minutes and a filtration was carried out. The reagents were taken in glass tubes following the same order as the standard curve. The extract from the sample, water and Folin Ciocalteau was added, stirred and after 3 minutes 20% sodium carbonate was added. Then the tubes rested for 30 minutes in a water bath at 37°C. The readings were made in a spectrophotometer at an absorbance of 765 nm. White was prepared with the same method but without the addition of the vegetable extract.

- Chlorophyll and carotenoids: Chlorophyll and carotenoids were determined according to the Lichtenthaler method [17] with adaptations, first weighed the sample, placed in a mortar with 0.2 g of calcium carbonate and 3 ml of 80% acetone, macerated and the extract transferred to a falcon tube, the volume being made up to 5 ml. Subsequently, it was centrifuged for 10 minutes at 10°C and 3000 rpm. An aliquot was taken in a cuvette and the spectrophotometer readings were taken at absorbances of 470, 646 and 663 nm respectively.

2.4 Statistical Analysis

The data were submitted to analysis of variance, when detected significant effect for the test F was applied the test of Tukey at the level of 5% of probability. To evaluate the influence of one parameter on the other, the Pearson correlation coefficients were determined. Data were analyzed using the AgroEstat® statistical package [18].

3. RESULTS AND DISCUSSION

The interaction between the different techniques of water uptake and rooting levels had a significant effect ($p < 0.05$) on the fresh mass of the spikes with straw and without straw (Fig. 1A - 1B). Grains and cob were not significantly affected (Fig. 1C - 1D). Results also observed by Berticelli and Nunes [19] when they studied the effect of rooting in maize, verified that the plants and ears where rooting was applied increased productivity. It was observed a better performance in the technique without rooting with values of 281.0 g in the ear with straw and 158.0 g in the ears without straw (Fig. 1A - 1B), it is observed that these variables are close to the literature. Couto et al. [20] that analyzed the performance of corn cultivars found on average 320.0 g for ears with straw. In the study by Favarato et al. [21] 261.0 g were found when studying the growth and yield of green maize.

The fresh mass of the grains and the cob differed significantly from each other (Fig. 1C - 1D), obtaining a value of 88.0 g in the spikes of the basin system without rooting, differently from the result found in the cob, which presented better performance with 83.0 g in the heads of the rowan system with rooting. The variables related to the fresh mass of the spikes do not present, in the majority of cases, better responses to the rooting, except for the fresh mass of the bush in the heap system, being different from the work of Berticelli and Nunes [19] when evaluating the efficiency of rooting use in the crop of corn, an increase in the number of grains was usually observed with the treatment. Santos and Carlesso [22] report that this characteristic can be directly related to the physiological conditions since the rooting stimulate the root development improving the conditions making the water better absorbed by the plant.

There was a positive correlation between the variables of fresh straw mass with straw and without straw (Table 1), this may be related to the fact that these characteristics showed the same behavior, where the highest performance was in the spikes extracted from the heap system without rooting application. The other characteristics related to fresh mass did not present an intense positive correlation with each other, due to the fact that they differ statistically.

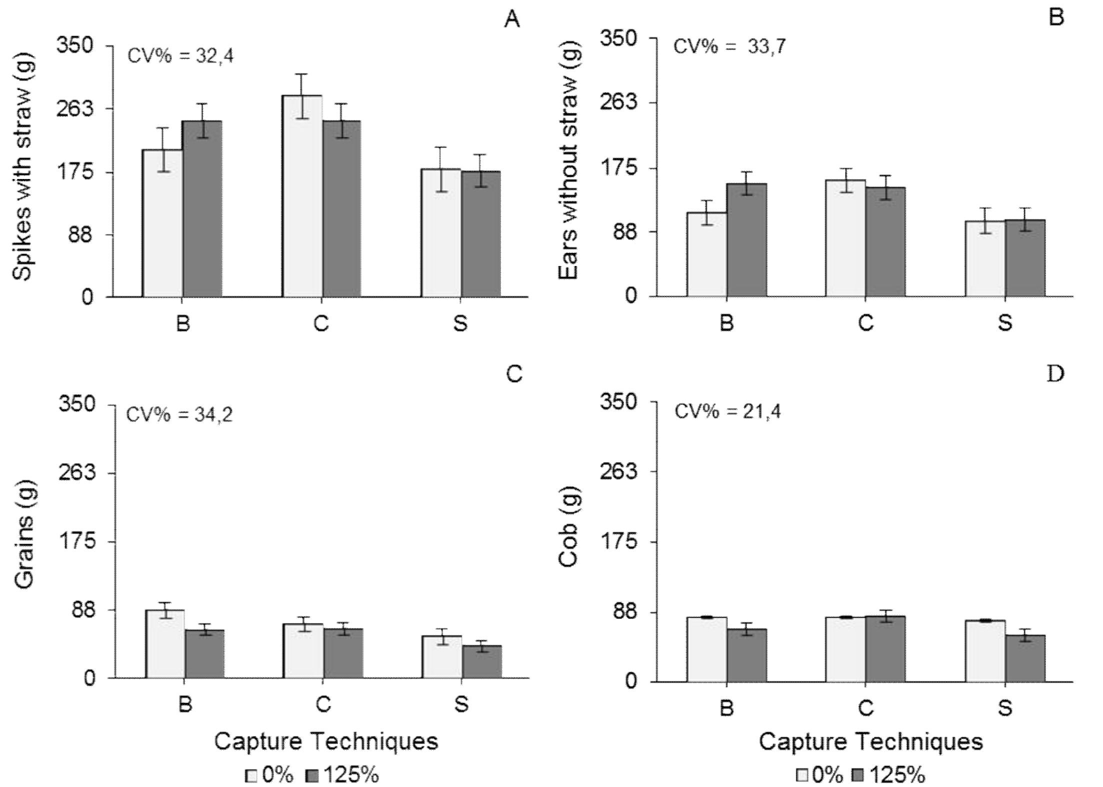

Fig. 1. Fresh pasta: spikes with straw (A), ears without straw (B), grains (C) and green corn cob (D) produced in different harvesting techniques under concentrations of commercial rooting
(B: basins, C: mounds, S: juice, CV: coefficient of variation)

Table 1. Correlation analysis table between the variables of fresh mass of green maize produced in different harvesting techniques under concentrations of commercial rooting

Variables	FSMWS	FSMWS	FGM
FSMWS	0.90845**	-	-
FGM	0.39612**	0.35605**	-
FMC	0.38874**	0.282173*	0.46330**

*FSMWS: fresh spike mass with straw, FSMWS: fresh spike mass without straw, FGM: fresh grain mass, FMC: fresh mass of corn. (**: significant)*

A significant interaction ($p < 0.05$) between the different water harvesting techniques and the rooting levels in the variables length, basal diameter and number of grain of the spikes was observed (Fig. 2A - 2B - 2F), however, in the mean diameter, apical and number of rows did not present significant interaction (Fig. 2C - 2E). Santos and Carlesso [22], when they evaluated the water and physiological deficit of the plants, explained that there was an increase in the number of grains in the spikes of plants treated with rooting, they inform that this characteristic is directly related to the physiological conditions, considering that the rooting stimulates the root development improving the conditions making the water better absorbed by the plant. The results obtained for the length of the spikes differed statistically in the evaluated treatments (Fig. 2A), is the system of basins with rooting the one that presented better performance with 19.7 cm. However, the best spikes were obtained in the rooting system without rooting with 20.9 cm. The results were close to those reported in the study by Couto et al. [20] when studying the performance of cultivars of green corn the length was 18.6 cm.

The basal diameter presented a significant interaction (Fig. 2B). In the basin system with rooting and mounds without rooting, the same values were obtained with 4.2 cm. The mean diameter did not show a significant difference (Fig. 2C). It was observed that the rooting system had better performance with values of 4.5 cm. In the apical diameter showed no differences and interaction of significant effect (Fig. 2D), the same behavior was observed in the apical diameter of the basin system with rooting and ridges without rooting with values of 3.7 cm. The dimensions of the spikes presented values close to those cited in the work of Couto et al. [20] when evaluating the performance of maize cultivars obtained an average of 4.4 cm in diameter. Favarato et al. [21] when analyzing the growth and yield of green maize on different soil cover in no-tillage and organic system, found the diameter of ears without straw of 4.8. However, the apical diameter of all treatments in this study was lower. Cardoso et al. [23] when studying the performance of green maize cultivars report that length and diameter are important parameters for commercial quality. Pereira Filho [6] informs that the standards required in the marketing of ears of green corn are 15 cm in length and 3 cm in diameter, all results obtained in this work being commercially available.

The number of rows per spike did not differ statistically in the evaluated treatments (Fig. 2E), even though it was possible to observe that in all the systems of capture with the application of rooting, the results were superior, being the best values of the spikes removed from the system ridges with 19 rows. On the other hand, the number of grains per spike (Fig. 2F) showed a significant effect interaction, with the spikes of the rooting basin system having the highest yield with 550 grains. These values are close to those reported in the work of Novakowiski et al. [24], which found 14 rows per ear when analyzing the residual effect of nitrogen fertilization on maize crop, averaging 30 grains per row, reaching a value of 420 grains per corn ear. In the work of Berticelli and Nunes [19], it was observed that the number of rows and grains in the spikes of the plants treated with rooting were higher.

There was a high positive correlation between the variables length, basal diameter, apical diameter and number of grains per spike (Table 2). This may be due to the fact that all of these characteristics, except for the apical diameter, show a significant effect interaction, the apical diameter did not present significant difference the variable obtained the same characteristics of the length.

Table 2. Correlation analysis table between the variables of length, diameters, number of rows and grains of green maize produced in different capture techniques under concentrations of commercial rooting

Variables	SP	BD	MD	AD	NR
BD	0.82164**	-	-	-	-
MD	0.46257**	0.53765**	-	-	-
AD	0.72882**	0.88632**	0.49445**	-	-
NF	0.42973**	0.42461**	0.58245**	0.46592**	-
NG	0.75978**	0.86209**	0.48616**	0.78288**	0.60302**

*SP: spike length, BD: basal diameter, MD: mean diameter, AD: apical diameter, NR: number of rows per ear, NG: number of grains per ear. (**: significant)*

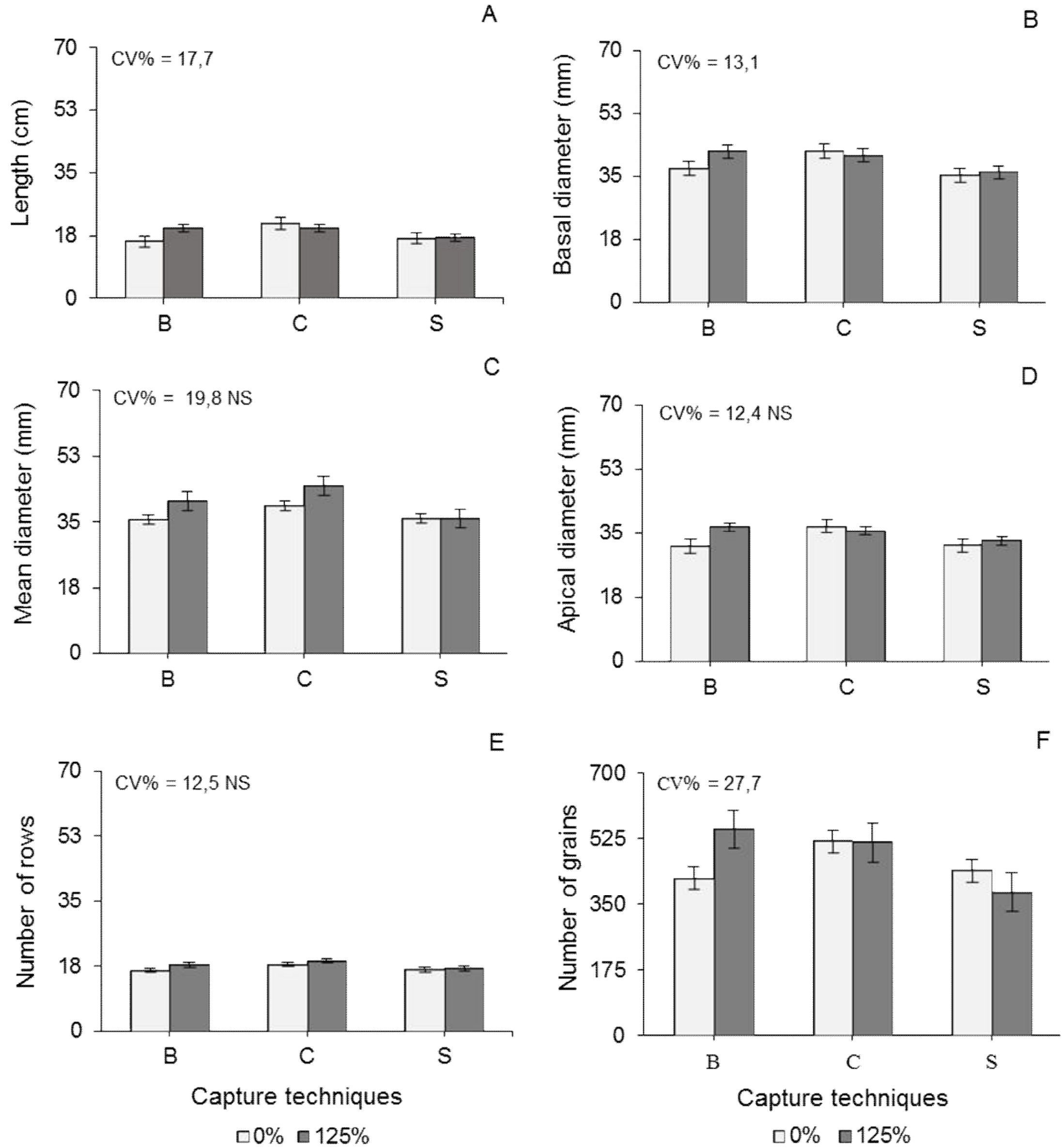

Fig. 2. Length (A), basal diameter (B), mean diameter (C), apical diameter (D), number of rows per spike (E) and number of grains per spike (F) of green maize produced in different concentrations of commercial rooting

(B: basins, C: mounds, S: juice, CV: coefficient of variation, NS: not significant)

There was interaction between the different techniques of water uptake and rooting levels had a significant effect ($p < 0.05$) on the electrolyte extravasation variable (Fig. 3D), while the soluble solids variables (Fig. 3A) and ascorbic acid (3B - 3C) and the titratable acidity (Fig. 3E) did not differ statistically from each other, nor were they significantly affected by interaction. Berticelli and Nunes [19] reported that the use of rooting in corn favors the plants and spikes physiologically contributing in their development.

It was observed that soluble solids differed statistically from each other (Fig. 3A), with values of 15% in rooting systems and furrow rooting systems, this response may be related to maize maturation stage or sample preparation conditions. Note that this result was close to that found in the work of Mamede et al. [25], who found values between 12.2 and 12.3% when studying the post harvest conservation of minimally processed green maize. According to Mamede et al. [26] differences in sugar levels can be attributed to variability between the collection points of spikes, since the removal of spikes from the field causes the sugars to be consumed in the respiratory process, besides being used for the synthesis of starch.

When evaluating the pH, it was observed that there was no significant difference between the treatments (Fig. 3B), where the values found ranged from 5.0 in the rooting system to 6.0 in all other systems and both treatments. In the work of Pinho et al. [27] when analyzing the quality of different types of green maize in two production systems, the pH values in the conventional planting system was 6.8, being close to the result found in this work.

It was not observed a significant difference in the concentration of H^+ ions, this variable is directly related to the pH levels being inversely proportional in the work of Carmo e Silva [28] when studying the electrical conductivity and

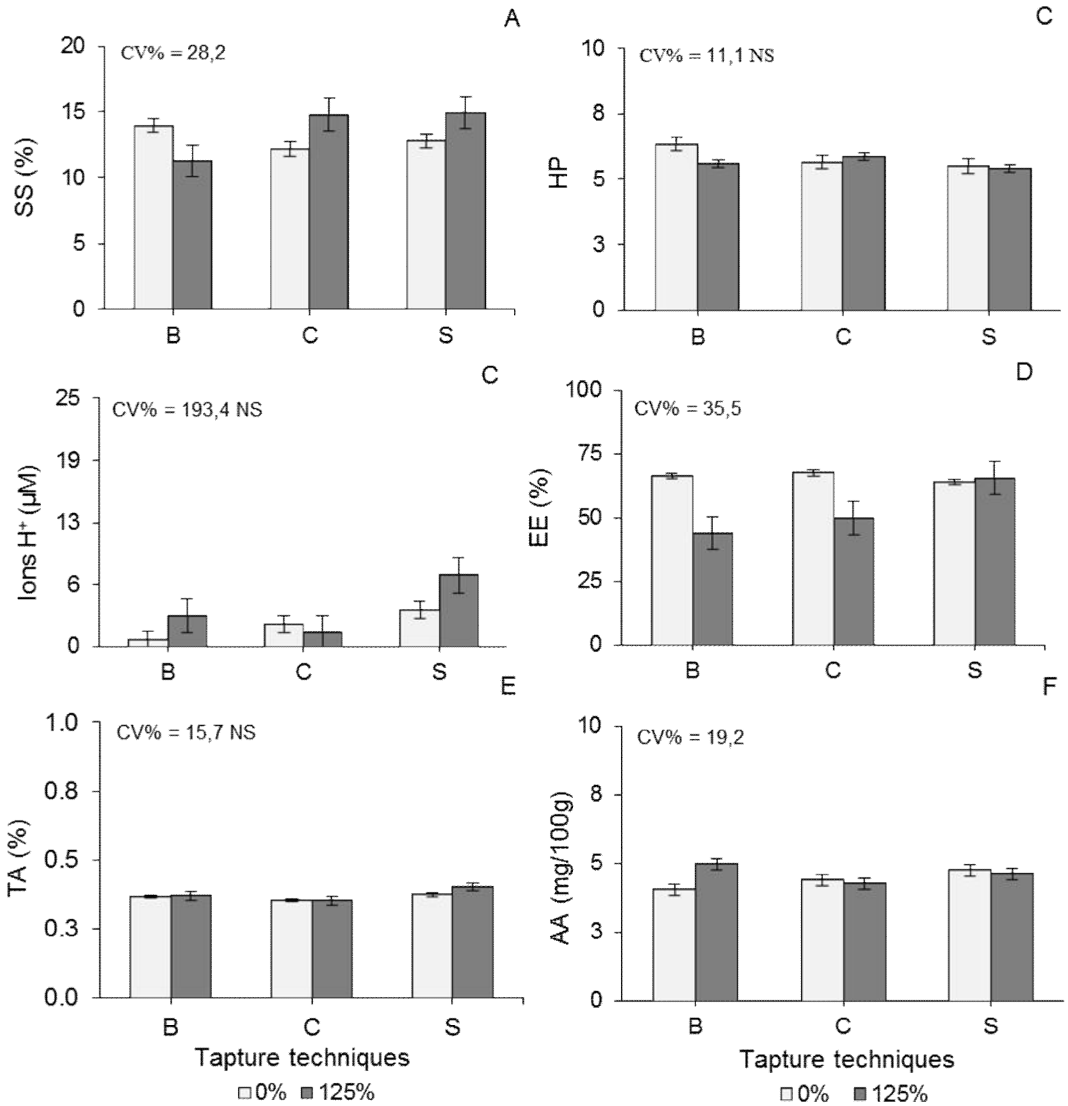

Fig. 3. Soluble solids (A), hydrogenation potential (B), concentration of H + (C) ions, electrolyte extravasation (D), titratable acidity (E) and ascorbic acid (F) of green maize produced in different harvesting techniques of water using two concentrations of commercial rooting
(B: basins, C: mounds, S: juice, CV: coefficient of variation, NS: not significant)

corn growth in contrasting soils under different levels of liming, reported that the increase in pH is attributed to the neutralization of H^+ ions by OH ions. This explains the negative correlation expressed in this work (Table 3), where the treatments presented values ranging. from 1.0 to 7.0 µM H^+ ions (Fig. 3C), wherein the system the hulls with rooting lower pH levels, consequently generating higher results for H^+ ions.

The extravasation of cellular electrolytes measured in the spikes differed statistically between, being smaller in the spikes removed from plants of the basin system without rooting (Fig. 3D). According to Fioreze et al. [29] when they studied the physiology and production of soybeans under water deficit, they reported that under environmental stress conditions, particularly in the water deficit, it promotes an increase in cellular electrolytes, this may be related to the lower extravasation of the plants treated with rooting in this work. Bajji et al. [30] reported that electrolyte extravasation allows the determination of the integrity level of cell membranes, since the lower the electrical conductivity of the solution, the fewer electrolytes leak in the membranes, that is, the membrane damage may be related to the first signs of stress, however, factors such as plant nutritional status and genetic factors may also influence these damages.

The titratable acidity contents did not differ statistically from each other, presenting values of 4.0% in all evaluated treatments (Fig. 3E), it was observed that the acidity was the same independent of the system of water uptake or application of rooting, the results presented in this study were superior to those found by Mamede et al. [25] with values varying from 0.10 to 0.24% when they studied post harvest conservation of minimally processed green maize. This difference may be related to the maturation time of green corn ears, to the preparation and analysis of the samples, to environmental factors from the region where the experiment was implanted.

There was a significant difference in the ascorbic acid levels (Fig. 3F), with treatments presenting values that ranged from 4.0 mg/100 g to 5.0 mg/100 g, especially for the basin system that presented better performance with the use of rooting. It can be observed that the ascorbic acid contents of the green corn of this work were inferred from those reported in the work of Pinho et al. [31], when studying the characteristics of green maize for the production of mini corn, found ascorbic acid values ranging from 9.5 to 11.5 mg/100 g, this characteristic may have occurred because ascorbic acid was easily altered during the steps in the production process [31].

The pH established a high negative correlation with H^+ ions, which may have occurred because these characteristics are inversely proportional, ie, the higher the pH the lower the amount of H^+ ions and vice versa (Table 3). It was verified that the titratable acidity showed a positive correlation with the soluble solids, this may be related to the fact that these variables present a similar effect.

An interaction between the different water harvesting techniques was observed, where rooting levels had a significant effect ($p < 0.05$) for flavonoid and phenolic compounds (Fig. 4A - 4B), the chlorophyll variable differed significantly (Fig. 4C) and the carotenoids were not significantly affected (Fig. 4D). Berticelli and Nunes [19] studied the performance of rootstocks in maize, which showed that in the spikes extracted from the plants where rooting was applied, they showed a higher amount of water, which contributed to the increase of the photosynthetic rate, increasing the pigments responsible for photosynthesis, collaborating in the development of spikes.

Table 3. Correlation analysis table between soluble solids, pH, H + ion concentration, electrolyte extravasation, titratable acidity and ascorbic acid of green maize produced in different capture techniques under concentrations of commercial rooting

Variables	SS	pH	H^+	EE	TA
pH	-0.0733^{NS}	-	-	-	-
H^+	0.0456^{NS}	-0.6907**	-	-	-
EE	0.0317^{NS}	-0.0264^{NS}	0.0130^{NS}	-	-
TA	-0.1982^{NS}	0.0798^{NS}	-0.1441^{NS}	0.0140^{NS}	-
AA	0.3697**	-0.0548^{NS}	-0.0292^{NS}	-0.0615^{NS}	-0.1347^{NS}

*SS: soluble solids, pH: hydrogenation potential, H^+: concentration of hydrogen ions, EE: extravasation of electrolytes, TA: titratable acidity, AA: ascorbic acid. (**: significant, ^{NS}: not significant)*

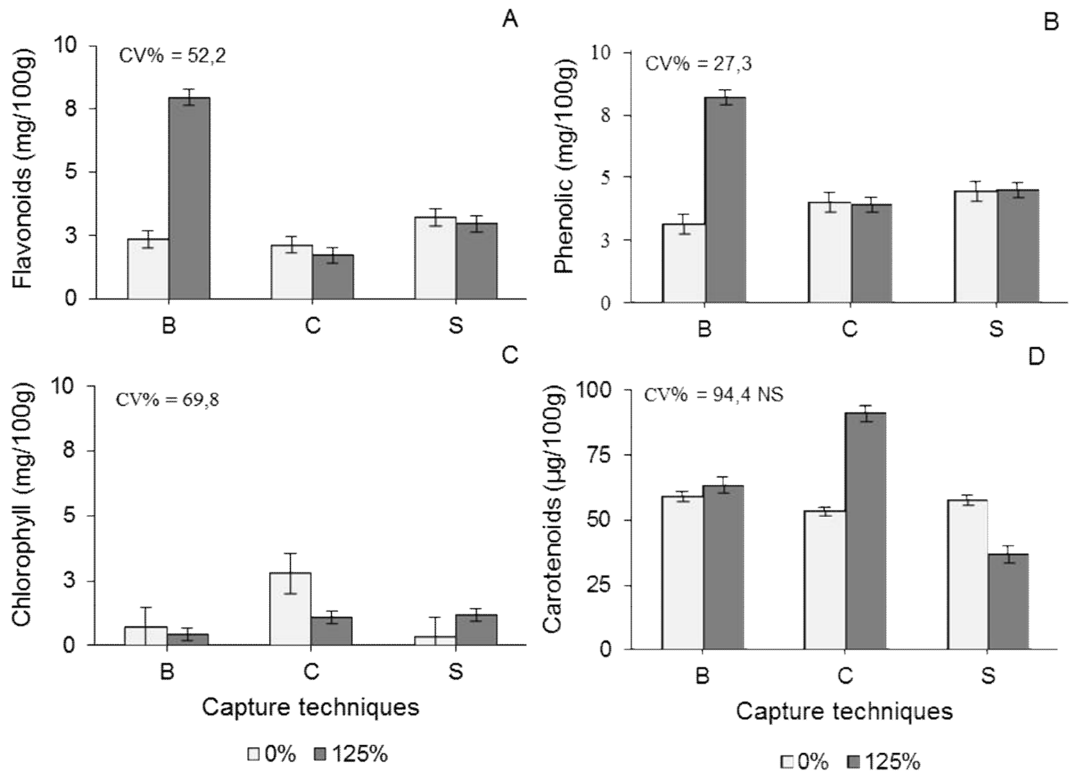

Fig. 4. Flavonoids (A), phenolic compounds (B), chlorophyll (C) and carotenoids (D) of green maize produced in different water harvesting techniques using two concentrations of commercial rooting

(B: basins, C: mounds, S: juice, CV: coefficient of variation, NS: not significant)

The flavonoid content differed statistically with values of 8.0 mg/100 g in the rooting basin system (Fig. 4A). It was observed that the rooting agent increased the flavonoid values of the cultivated green maize. No studies related to the number of flavonoids in green maize were found. However, Honório [32] reported that in the majority of works related to the flavonoid content some type of treatment is applied in order to increase the production of this metabolite.

A significant difference was observed in the phenolic compounds contents, the highest values presented were 8.0 mg/100 g in the basin system with the rooting application (Fig. 4B). It was verified that the use of rooting influenced the phenolic compounds values of the corn produced. In the study by Paraginski et al. [33] the number of phenolic compounds in the dried corn kernels stored were between 1.5 and 1.7 mg/g, respectively. It is observed that the values found in this research were higher than those reported by the authors. According to Lopez-Martinez et al. [34]; Xu and Hu [35]; Zilic et al. [36] pigments such as carotenoids and phenolic compounds are responsible for the color of dry corn grains recognized for their antioxidant capacity, that is, the pigmentation content in corn is associated with antioxidants and phenolic acids with health benefits.

The chlorophyll content of the evaluated green maize differed significantly, with the values of the spikes removed from the system without rooting of 2.8 mg/100 g (Fig. 4C). It can be noticed that the applied rooting did not influence the chlorophyll content of the spikes. Studies related to chlorophyll content in green corn cobs are not easily found. However, the study by Fonseca et al. [37] when evaluating leaf chlorophyll content in Bt maize hybrids, found that at the physiological stage R4 presented a significant difference for leaf chlorophyll content, thus influencing a higher grain weight, this is because the upper part of the plant is more photosynthetically active. According to Fiorini et al. [38] during the physiological maturity of the grain, water loss in plant tissues decreases the production of chlorophyll until all the photosynthetic activity stops. Thus, chlorophyll quantification is relevant during cultural management practices aiming at increasing the photosynthetic potential to increase yield [37].

The carotenoids did not differ statistically, presenting values from 31.0 to 64.0 µg/100 g (Fig. 4D). The best results were found in the spikes of the basin system with the rooting application. In Barbosa's work [39] the carotenoid contents in grains of different cultivars of green maize varied between 11.5 and 15.9 µg/g, respectively, it is noticed that the values found by this author were lower. According to Cândido [40], the low carotenoid content in green maize may be associated to the period of development and physiological maturation since the suspension of carotenoid synthesis occurs after harvest.

It was observed a positive correlation between the contents of phenolic compounds and flavonoids, both of which presented higher values in the basin system with the application of rooting (Table 4). The other parameters evaluated did not present a positive correlation with each other.

Table 4. Correlation analysis of the variables of flavonoids, phenolic compounds, chlorophyll and carotenoids of green maize produced in different capture techniques under concentrations of commercial rooting

Variables	CH	CA	FL
CA	-0.26785*	-	-
FL	0.0375^{NS}	0.06367^{NS}	-
PC	-0.0448^{NS}	0.01082^{NS}	0.78617**

CH: chlorophyll, CA: carotenoids, FL: flavonoids, PC: phenolic compounds.
*(**: significant, ^{NS}: not significant)*

4. CONCLUSIONS

The techniques of water harvesting in its basin and mounds with the use of rooting provided a higher yield of the crop, as it allowed the accumulation of water in the structure of the plants, producing ears with commercial characteristics.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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