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Rooting Induction in *Allium cepa* for the Study of Mitosis in a Hydroponics System

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Authors' contributions

This work was carried out in collaboration among all authors. Authors GAS, EFA and EO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MNL, VRSM, JAFJ, MJHL and LCA managed the analyses of the study. Author MNL managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The study of cell division processes is important for the understanding of how genetic information is transmitted from cell to cell and to descendants. To observe the phases of mitosis in meristematic cells of the onion root (*Allium cepa*), it is necessary to induce the rooting of this bulb that can be influenced by some factors like the type of water and the preparation form of the bulb of the onion for the success of rhizogenesis. In view of the above, the objective was to evaluate the influence of the water source and the opening of holes in the stem of the propagule to induce rooting in a hydroponic system. Two experiments were installed. In the first, one of the treatments was used distilled water and treated water. In the other experiment, three treatments were evaluated (without

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holes, few holes and a lot of holes in the stem of the bulb). Five days after installation of the first experiment, data were collected on the number of bulbs that gave off roots and this variable was analyzed using the X2 test. In the other test, also at five days, root number and fresh root mass data were obtained and the data were submitted for analysis of variance and the means were compared by the Scott-Knott test. For the induction of rooting in onion bulbs (*Allium cepa*) in a hydroponic system, water should be used, preferably treated, cleaned and decontaminated. The stem of the onion bulb should receive many perforations to facilitate the absorption of water with the essential nutrients for rooting.

Keywords: Genetics; cell division; meristematic cells.

1. INTRODUCTION

Genetics is one of the branches of biology that has been considered difficult for most high school and college school students to understand, such as cell division processes called mitosis and meiosis [1,2].

In the forestry area, the formation of large plantations with superior and uniform genetic material has as its principle the process of mitosis, making its understanding of fundamental importance [3].

The study of mitosis is important for understanding how genetic information is passed from cell to cell and from generation to generation. This information is contained in DNA, which in turn is associated with proteins constituting chromosomes [4,5,6,7].

An attractive and facilitating way to understand mitosis is by monitoring the behavior of chromosomes during cell division that can be observed with the preparation of cytological slides with cells from the meristematic root region of onion (*Allium cepa*) [8,9].

There are several protocols available in the literature for visualizing the phases of onion mitosis and starts with the induction of bulb rooting. This rooting promotion can be influenced by factors such as the type of water to be used and the way the bulb stem is prepared, such as the intensity of perforation of this part of the propagule.

Given the above, the objective of this study was to evaluate the influence of the water source and the opening of holes in the stem of the propagule for the induction of the onion bulb (*Allium cepa*) rooting.

2. MATERIALS AND METHODS

The experiments were carried out in the plant physiology laboratory of the Academic Unit of Forest Engineering (Unidade Acadêmica de Engenharia Florestal - UAEF) of the Federal University of Campina Grande (Universidade Federal de Campina Grande - UFCG), Patos Campus -PB.

Twenty-four healthy and vigorous onion bulbs were purchased from the municipal market of Patos (PB). With the aid of a penknife, the dry cataphylls (modified leaves) and the old roots of the meristematic region of the roots were carefully removed from the bulbs.

In electronic digital scales (resolution: 0.01 g) the onion bulbs were weighed and the average weight of each bulb (98.91 g) was obtained.

In each onion bulb, using a needle tip stylet four perforations were made in the basal plate region (modified item, flattened), and placed in an opaque white disposable cup with 150 ml volumetric capacity containing water so that only the base of the bulb came into contact with water. Water was changed daily until the end of the experiment, which occurred five days after installation.

Using these procedures two experiments were installed. The first in a completely randomized design with two treatments, 12 replications and each portion constituted by an onion bulb.

One of the treatments was distilled water and the other treated water collected directly from the distribution network (tap).

The chemical analysis of the two samples of water sources was performed at the UAEF / UFCG soil and water laboratory (Table 1).

At five days, data were collected on the number of *Allium cepa* bulbs that emitted roots with a length equal or greater than 1.0 cm. These data were used in the Chi-square test (X^2).

After obtaining the results of this experiment, it was installed the second experiment, with three

Table 1. Chemical analysis of samples from both water sources

Sample	pH	CE $dS.m^{-1}$	Ca	Mg	CO_3^{-2}	HCO_3	Cl	Na	K	RAS
						$mmol.L^{-1}$				$(mmol\ L^{-1})^{0,5}$
Distilled Water	7,0	0,0	0,0	0,0	0,0	0,08	0,0	0,0	0,0	0,0
Treated Water	7,4	0,28	0,6	0,8	0,0	2,08	1,2	1,17	0,18	1,4

Source: UAEF / UFCG Soil and Water Laboratory, Patos Campus-PB

treatments (no holes, few holes - 04 perforations and many holes - 08 perforations in the bulb basal plate) and 8 repetitions using normal water. The delineation and experimental unit were similar to the previous experiment. At five days, data were collected on root number and fresh root mass (g). Fresh mass was determined using an electronic digital scale (resolution: 0.001g).

Data were submitted to the Shapiro-Wilk (W) normality test, analysis of variance, F test and the means compared by the Scott-Knott test.

Fresh root mass data were transformed into Square Root to meet normal distribution and analysis, however, they were used as original averages. All analyzes were performed using the statistical software “ASSISTAT” [10].

3. RESULTS AND DISCUSSION

Treatment using normal water for rooting onion bulbs was superior to the distilled water treatments (P <0.01) (Fig. 1).

It is observed that all onions in normal water have taken root, while in distilled water only one has taken root.

Onions grow best at pH 6.0 to 6.5 [11]. The pHs of both types of water were very close to this range and possibly did not influence this difference in rooting.

Water distillation removes nutrients as can be seen in Table 1. In the literature there are reports that the nutrients present in onion cataphylls are sufficient for rooting induction. However, the results obtained here show that these nutrients are not available and are absorbed in the nutrient solution, resulting in rooting of the onion in normal water that already has the necessary nutrients for root development (Table 1).

The mineral elements determined in the chemical analysis of normal water were Ca, Mg, Cl, Na, and K.

The main important nutrients for the process of root differentiation and formation are nitrogen, phosphorus, potassium, calcium, boron and magnesium [12].

Onion roots are adventitious because they are of stem origin. Lopes [13] reports that mineral nutrition is very important for the formation of adventitious roots. The author also reports that during the adventitious root induction phase, potassium acts in several biochemical events being enzyme activator, osmotic pressure regulator, stomata control and carbohydrate transport.

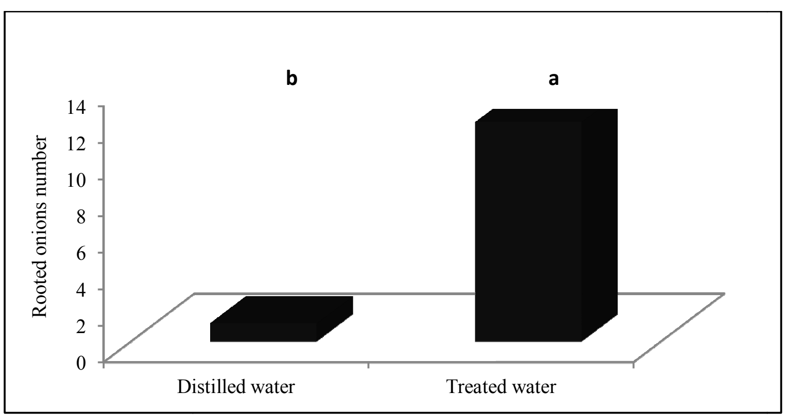

Fig. 1. Number of onions (*Allium cepa*) rooted in distilled water and normal water
** Number of rooted onions differ from each other by Chi-square test (p < 0.01)*

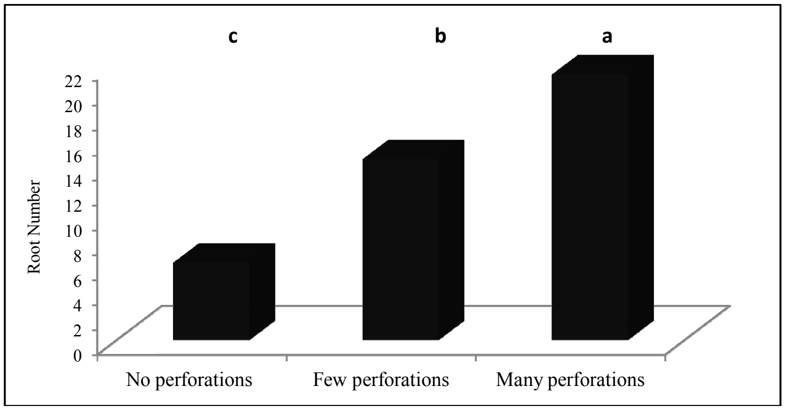

Fig. 2. Average numbers of onion roots (*Allium cepa*) submitted to three levels of perforation in the bulb basal plate (stem)

**Averages followed by the same letter do not differ from each other by the Scott-Knott test (P > 0.05)*

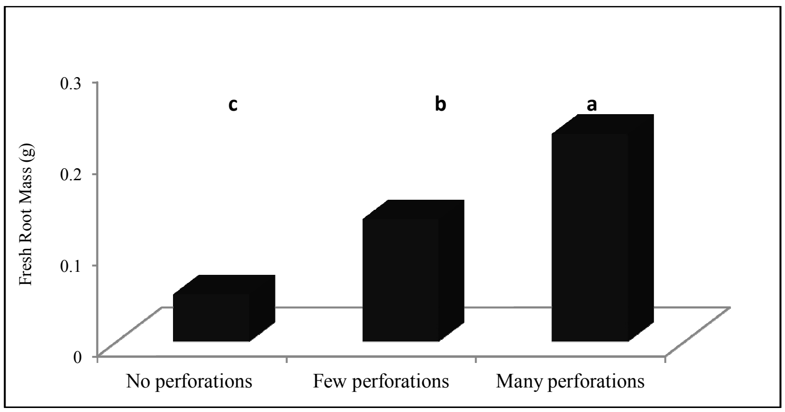

Fig. 3. Averages of fresh onion root mass (*Allium cepa*) submitted to three perforation levels in the bulb basal plate (stem)

** Averages followed by the same letter do not differ from each other by the Scott-Knott test (P > 0.05)*

Calcium (Ca) exercises function in root elongation [14]. Aguiar Neto et al. [15] observed that this element was the most accumulated nutrient in the "Texas Grano 502" and "IPA 11" cultures of the *Allium cepa* species in an experiment conducted in Petrolina-PE.

Magnesium (Mg) plays an important role in the synthesis of nucleic acids, proteins and respiration that are fundamental for the induction of root beginnings [14].

Treatment with many perforations in the onion bulb stem provided the highest mean number of roots (Fig. 2) and fresh root mass ($P < 0.05$) (Fig. 3).

The holes facilitate water absorption by providing the important nutrients for the induction of adventitious roots in the *Allium cepa* species. The more injuries to the propagule, the greater the chances of phytopathogen attacks. However, no problems were observed regarding root health from installation until the end of the experiment.

4. CONCLUSIONS

To induce rooting in onion bulbs (*Allium cepa*) in the hydroponics system, preferably treated, clean and decontaminated water should be used. The stem of the onion bulb (basal plate) should be punctured to facilitate water absorption with the nutrients essential for rooting.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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