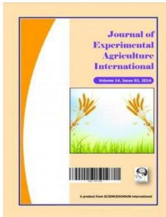

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The Performance of Capsicum Seed Germination in Different Micronutrient-treated Substrates

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

The use of chilli pepper (*Capsicum frutescens*) in cooking is common; however, the increase in the use of family farming also as a defensive has led to an increase in the cultivation of this condiment in both the northern and southern coastal regions of Alagoas. In the latter, the cultivation by the small producers is so intense that the local cooperative has embraced the initiative and assumed the responsibility of transferring all the production of such raw material to a processing plant located in the neighbouring state. With such influence and increased production, he began to perceive some seed issues that could hinder his production in the field, such as fungus susceptibility and lack of some essential micronutrients, due to nutrient poverty on the Alagoan coast. Due to this observation, the commercialization companies already treat the seeds with fungicides; however, the lack of nutrition still needs to be overcome. An alternative is treatment of the substrate with micronutrients, which in this study has proven effective in meeting such a need.

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1. INTRODUCTION

The need for more vigorous commercial planting has made fertilizer improvement research a vast and, at the same time, repetitive subject with comparisons and doses of certain assets found in rural areas.

The lack of economical and efficient options has led small farmers to go into debt by trying to compete in a disloyal and struggling market that is growing and devastating those who do not adapt to it.

Long before Columbus arrived in the Americas, peppers were already widely used in Central and South America, the Caribbean and Mexico. The oldest recorded instances of pepper cultivation were found at archaeological sites in Tehuacán, Mexico, and date back to about 9,000 years. The Aztecs used the fruits of Capsicum to flavour a cocoa-based drink, tchocoatl, the precursor of chocolate [1].

It is now cultivated in tropical-climate regions with variable rainfalls of 600 to 1,200 mm and average temperatures of around 25°C. Temperatures lower than 15°C impair the vegetative development of the plant. Soil that presents a light texture with a pH between 5.5 and 6.0 with good drainage is most recommended. The harvest is done manually, from 100 to 120 days after planting, and the average yield per hectare varies from one cultivar to another. The chilli produces 10 t^{-ha}. Harvesting in the first year is always bigger, and many planters prefer to renew their cultures [2].

Researchers around the world have mobilized to try to economically and affordably bring inexpensive options to those who cannot afford genetically modified products. These options are necessary in order to enable small producers to adapt to cultural management simply by *implementing*, in a simple way, a product that will improve the performance of their harvests.

According to BRASIL [3], plants have specific nutrient needs; they require the supply in the right quantity and in the proper form .Plants have specific needs, micronutrients are *not seen or noticed.*

Within this context, we find chilli pepper, which has experienced growing commercial interest within the state of Alagoas and has replaced large areas where sugar cane monoculture was once imperative. It has unite small producers in favour of a change not only of paradigms but of lifestyles.

The initial proposal is to insert a micronutrient at the moment of transplantation of the seedling into the pit that reduces the susceptibility of the plant to the attack of pathogens and that participates in essential processes in the metabolism of the plant. According to KIRKBY and RÖMHELD [4], there is increasing evidence that Zinc (Zn), by maintaining the structure and integrity of the membrane and controlling permeability, also protects the plant from various pathogens. In plants deficient in this micronutrient, the membranes become permeable such that carbohydrates and amino acids are released, attracting pathogens and insects to both its roots and shoots.

Zinc is also required for generative growth, and the viability of pollen is highly dependent on an adequate supply of this nutrient [5]. Thus, the lack of this micronutrient can make all the difference between the exit from the vegetative state to the *reproduction of the* adult plant.

Zn is the most limited micronutrient to crop productivity in Brazil. Your most common way in the soil solution is a Zn 2+ that moves in the ground by diffusion, walking a favour gradient of concentration, that is, from higher concentration to lower concentration [6].

Plants predominantly absorb zinc as Zn^{2+}. In that same form, it is transported long distances, from the roots to the shoots, by the xylem [6]. Some nutrients may have interactions with Zn, affecting its absorption by the plants. Interactions of the type 6 competitive relationships are between P-Zn [7,8,9]; Ca-Zn [10]; Fe-Zn [11,12,13] and Zn-Cu [14]. Regarding its redistribution, zinc presents low mobility in the phloem, and its greater or lesser translocation depends on its availability in the vegetative part [15].

An experiment conducted by VIÉGAS [16] showed that in the long pepper, the lack of some nutrients, including zinc, promotes the occurrence of visual symptoms of deficiency accompanied by a reduction in the foliar content of its respective nutrients. This reduces the plant's ability to carry out photosynthesis, which can be fatal to the plant.

The aim of this study is to determine the right choice of treatment of the substrate rather than the seed and to prevent any reaction of the chemical compounds found in the seeds treated with fungicide.

2. MATERIALS AND METHODS

The tests were carried out at the Plant Propagation Laboratory of the Department of Plant Production at the Agricultural Sciences Centre of the Federal University of Alagoas (UFAL), located at 9° 29' 45" South Latitude and 35° 49' 54".Two lots of chilli pepper seeds (C. frutescens L.) and three treatments other than the control were used.

Four replicates of four pre-tests were carried out with two different batches of chilli pepper to arrive at the best dosage to be applied in the official tests. Two untreated seed lots were used for each substrate. Four replicates were performed for each batch of each treatment.

Treated blotting paper was used as the substrate. It was placed in gerbox-type boxes, submitted to alternating temperatures of 20° to 30°C and 8 hours of light and controlled in a BOD (Biochemical Oxygen Demand) type incubator. The 32 gerboxes were identified following this model: Lot 1, Treatment 1, Repetition 1 = 1.1.1. The control was identified as Treatment 4.

Treatment 1	12 hours submerged in 1 ml solution of pure zinc with 52 ml of distilled water
Treatment 2	12 hours submerged in 1 ml solution of zinc + molybdenum with 52 ml of distilled water
Treatment 3	12 hours submerged in 1 ml solution of zinc + molybdenum + copper with 52 ml of distilled water
Treatment 4 (Control)	12 hours submerged in distilled water

The first count was made at 7 days and the last count at 14 days, as taught by RAS (Rules for Seed Analysis), to record the IVG (Speed Index Germination) according to the methodology described: Germination speed index - daily counts of seedlings emerged up to 14 days after sowing, and IVG was calculated according to Maguire's formula [17]:

$$IVG = \frac{G_1}{N_1} + \frac{G_2}{N_2} + \ldots + \frac{G_n}{N_n}$$

where:

> G1, G2 and Gn are the number of seeds germinated in the first, second and last counts, and N1, N2 and Nn are the number of days after sowing in the first, second and last *count*.

3. RESULTS AND DISCUSSION

The first count was done seven days after the germination test, in accordance with the RAS (Rules for Seed Analysis). It was observed that treatments 2 and 3 were not as good as the control; however, treatment 1 exceeded the expectation (see Fig. 1). This demonstrates that the application of this micronutrient to the pit, in the form of direct fertilization during the transplant period, can supply the initial need for *moulting* and increase the vigour of this seed by up to 38% in comparison to no treatment.

Zinc is absorbed by plants predominantly as Zn^{2+}; in that same form is transported long distances, from the roots to the shoot by the xylem [6]. Some nutrients may have interactions with Zn, affecting the absorption of the same by the plants. Interactions of the type 6 competitive relationships between P-Zn [7,8,9]; Ca-Zn [10]; Fe-Zn [11,12,13] and Zn-Cu [14]. Regarding redistribution, zinc presents low mobility in the phloem, and its greater or lesser translocation depends on its availability in the vegetative part [15].

In Fig. 2, we can see the final count of the germination speed test. Although treatment 1 was always highlighted and showed a better vigour, the germination rate in the final count was the same for the treatment with pure zinc, with zinc + molybdenum + copper and the control. It was also observed that the treatment with zinc and molybdenum did not generate any response from the chilli pepper culture when applied to the substrate.

The Tukey test was applied at 5% propolis using the SISVAR program. This test showed the high vigour that zinc provided in the planted seeds, statistically differentiating both treatment 3 and the control. Treatment 2, which consisted of Zn + Mo, did not respond, demonstrating that this treatment, applied to the substrate at the time of planting the chili pepper seed, should not be used, as it slows the germination or makes the seed unviable.

Based on the experiment conducted by VIÉGAS [16] mentioned previously, we can also say that the small farmer can benefit from these findings. The essential micronutrient zinc is not expensive and, when applied at the time of transplant, reduces costs. The application of zinc reduces the susceptibility of seeds or seedlings to the entry of pathogens and also increases the likelihood of uniformity in reproductive capacity.

The use of zinc in the substrate at the time of sowing of the chilli pepper or in the pit at the moment of the transplant of the seedlings increases the speed of the germination, makes the seedling more vigorous and help to maintaining the quality.

Zinc is also required for generative growth, and the viability of pollen is highly dependent on an adequate supply of this nutrient [5]. Thus, the lack of this micronutrient can make all the difference between the exit from the vegetative state to the *reproduction of the* adult plant.

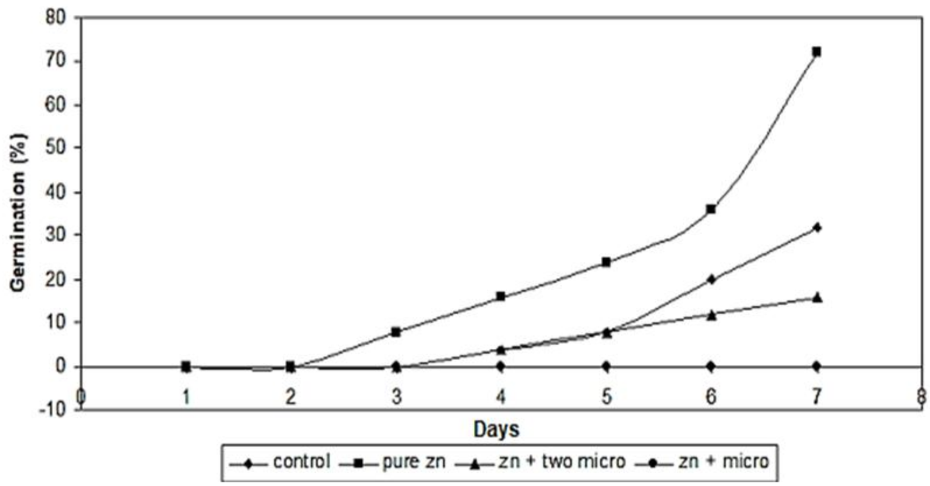
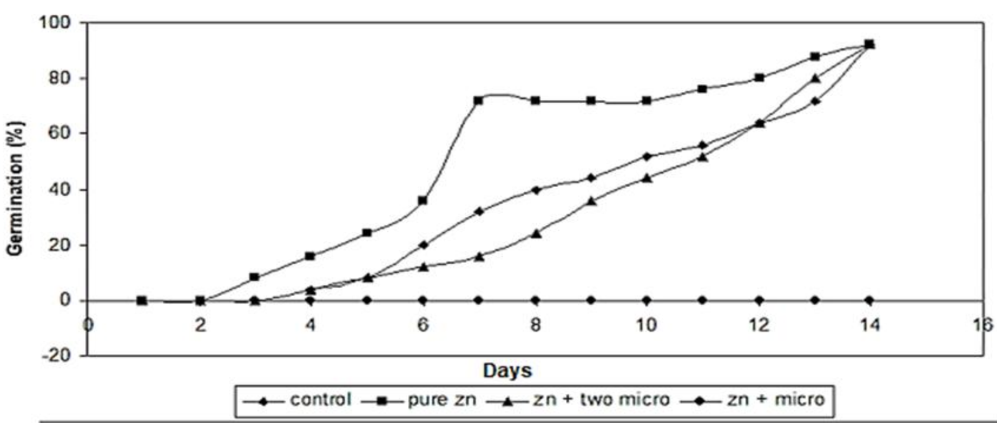


Fig. 1. First count of the germination speed index
The treatment with zinc surpassed the control



At the end of the fourteen days it can be seen that the percentage of germination was the same, although the treatment of pure zinc stood out during the whole process of germination speed, demonstrating greater vigor in relation to the other treatments.

Fig. 2. Germination speed index and final count

4. CONCLUSION

The use of pure zinc or zinc in combined with other micronutrients, such as molybdenum and copper, demonstrated favourable and successful responses. The use of zinc with molybdenum has already been proven to be an interaction that does not work. Based on this information, the use of this last interaction is not indicated.

The use of Zn, Cu and Mo is indicated for the accumulation of micronutrients, although they showed lower results than the control in the first count. However, they showed a good result along the IVG, indicating an increase in vigour.

Finally, pure Zn, which demonstrated improvement in the performance of pepper germination from the beginning, increased the vigour from the first count. In a fertilization recommendation for seedling formation, the use of this last source would be the most indicated.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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