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Testing Organic Fertilizers to Improve Seedlings Quality of Wild "Piquin" Chilli Pepper (*Capsicum annuum* L. var. *glabriusculum*) from Northeastern Mexico

Horacio Villalón-Mendoza[1], Rosa Isela Malacara-Ramírez[1], Fortunato Garza-Ocañas[1], Edwin Garza-López[1], Arturo Mora Olivo[2], José Guadalupe Martínez Avalos[2], Moisés Ramírez-Meráz[3]

[1]Universidad Autónoma de Nuevo León, Facultad de Ciencias Forestales, Linares, Nuevo León, México
[2]Universidad Autónoma de Tamaulipas, Instituto de Ecología Aplicada, Ciudad Victoria, México
[3]Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias, Rio Bravo, Tamaulipas, México
Email: horacio.villalon@gmail.com

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Abstract

The wild piquin chilli pepper (*Capsicum annuum* L. var. *glabriusculum*) is a species of great importance in the North-East of Mexico; however, its productions are not constant. In order to generate knowledge, it is important to carry out research on seedlings nutrition and assess the response of wild piquin chilli pepper with the addition of different systems and doses of fertilization in its productive performance. The objective of this research was to determine the effect of different kinds of fertilizer on seedling production of wild piquin chilli pepper under greenhouse conditions. The treatments that were used are: control, organic fertilizer applied as foliar, mycorrhiza (*Glomus intraradices*), Osmacote Plus® (15N-9P-12K) and the combination mycorrhizae and organic fertilizer. The variables considered in this study were: the seedlings height, foliage color, total leaf number, stem diameter and radical density. These variables were recorded every 15 days after its transplant, using 30 days old seedlings. Statistical analysis of data collected was made with the statistical package STATISTICA STATSOFT®. An analysis of variance and mean of the minimum difference (LSD) with a value of p = 0.05. Results for effects of different types of fertilizers tested were as follows: the best type was the organic fertilizer, followed by the Osmacote Plus, preceded by the application of mycorrhiza, after the control and with the lower results the combination of mycorrhiza and organic fertilizer.

Subject Areas

Agricultural Science

Keywords

Wild Piquin Chilli Pepper, Organic Fertilizer, Mineral Fertilizer, Mycorrhizae

1. Introduction

The wild piquin chilli pepper was unknown in Europe until the XVI century, it was introduced in Spain by Colombus on his trip back in 1493. The crop extended from the Mediterranean region to England in 1548 and to Central Europe near the XVI century. The Portuguese transplant reported *Capsicum* from Brazil to India before 1885; the crop was reported in China by ends of 1700 [1].

Mexico is the main center of distribution of *Capsicum annum* and Guatemala as a secondary center; the Amazon for *C. chinense* and *C. frutescens* are widely distributed from Mexico crossing Central America and in all regions of the Caribbean. *C. chinense* is the most common cultivated species in South America. All species exist in their own wild form, except for *C. pubescens,* which is only known under farming. In the United States *C. annuum* is the most cultivated species. Only the Tabasco and the green leaf Tabasco, both *C. fructescens,* are developed in limited extensions in Louisiana, and are used to make Tabasco sauce of mature red fruit, and the vinegar sauce of immature yellow-greenish chopped in vinegar. *C. pendulum* is the third developed species in a very limited extension in California [1].

The species *Capsicum annuum L.* is one of the most diverse in forms and sizes, according to Sahagun [2] in his Florentine Code he left testimony about things of the New Spain. Amongst them what is relative to chili, which had various denominations in accordance to the great variety of chilli cultivated. This has given origin to diverse courses that can be found in different regions of the country.

Yet in the case of *Capsicum annuum L.* var. *glabriusculum,* which is located in the northeast region of the country, there are variations that are not very notorious or hard to distinguish at a regional level, as it has great resemblance. Respectively, Medina [3] claims that the species cannot be differentiated by its fruits, but by the behavior that is shown in its development and reproduction.

The genus *Capsicum* has been widely studied, particularly in taxonomy, origin evolution and domestication process, yet there is still a lack of important aspects to solve since all the studies have been limited to the cultivated species and their nearest relatives [4], the scarce information that we have about it prevents taking advantage of the maximum potential within it.

This species is of great relevance for the habitants where it is distributed, as it provides food and extra income, but productions are not constant due to various factors, among them precipitations. In a study made by Medina [5], it is mentioned that there exist two seasons for the harvesting of the fruit: the early cycle (February - April), and the late one (August - November), getting yields from 50 and 125 tons respectively.

Wild piquin chilli pepper is a species that is found in the thornscrubs in Northeastern Mexico, and it is widely used by the habitants in the rural zones. Its characteristic scent and flavor make it unique and different from other varieties of chilli that can be found in other regions of the country [6]. The regional production of wild piquin chilli pepper that gets to the market seems limited by the harvests made from thornscrubs of the region of northeast Mexico [7] and, at the same time, by the prevailing climate conditions in each season of natural production, making an impact to the wild populations of this species by the inadequate form of harvesting the fruit. Thus, it is important to carry out research work to evaluate responses of wild chilli pepper seedlings to the addition of different systems and fertilization doses in productive behavior and, by this, to generate knowledge to make productive processes that integrate the sustainable management of the wild piquin chilli pepper natural resource, and by time depend less on the natural population [8].

The objective of the present research was to determine the effects of three organic fertilizers with potential use in the nursery, their effects on seedling growth and production under nursery conditions.

2. Materials and Methods

The study was made during December 2015 through February 2016 in the greenhouse and forestry nursery of the Faculty of Forestry Sciences of the UANL. Five fertilization treatments were tested in seedlings grown at the nursery and transplant used after 30 days in plastic trays with 38 cavities, with a volume of 200 cm^3 per cavity. For each treatment 4 repetitions of 10 seedlings each were used [9]. The treatments were the following:

T1 = Control.

T2 = Organic fertilizer (Vermi-compost) foliar applied.

T3 = Mycorrhizae (*Glomus intraradicens*) applied to the substrate.

T4 = Mineral fertilizer Osmacote Plus® (15-9-12) of slow release.

T5 = Combination of the treatments Mycorrhizae + Organic fertilizer.

2.1. Preparation and Application of the Organic Fertilizer (Vermicompost)

The preparation and application of the organic fertilizer (vermicompost) was made in a liter of water to which 200 milliliters of vermicompost were added (20% of concentration), agitated to be spilled later in an atomizer. The appliance of this fertilizer was foliar every 15 days during 3 months.

2.2. Application of the Mycorrhizae

For the application of the mycorrhizae 7.6 liters of substrate (peat moss + perlite) were added to each forest tray and a dose of 2.43 grams of mycorrhizae per liter of pre-moistened substrate was applied.

2.3. Application of the Mineral Fertilizer Osmocote Plus®

For the application of mineral fertilizer Osmocote Plus® 8.6 grams of Osmocote were applied for each liter of pre-moistened substrate, so that each tray (7.6 liters) needed a total of 65.36 grams of fertilizer.

The studied variables were:

- Height of the seedlings;
- Coloration of foliage;
- Number of total leaves;
- Diameter of the stem;
- Radical density.

These variables were registered every 15 days after their transplant, using 30 days old seedlings. The statistical analysis from the data gathered was made with the statistic package STATISTICA, STATSOFT®. Variance analysis and least significant difference mean comparison test were made with a significance level of $p = 0.05$.

3. Results and Discussion

3.1. Seedlings Height

In **Figure 1**, the behavior of the seedlings' height since its transplant to the tray is shown throughout the 3 months the study lasted.

Results showed that treatment 2 (organic fertilizer) in most of the time, starting from the second week, was superior to the other treatments. A similar situation occurred to [10] in a study of jalapeño pepper, where they observed that in the beginning of the test the pepper seedlings had a lightly slow growth, but as the leaves and root grown, the growing rate raised. In the present study Treatment 5 (mycorrhizae + organic fertilizer) had the least growth.

The final seedlings' height after 3 months of measurements was indeed strongly influenced by the tested fertilization systems, being best to apply organic fertilizer in foliar (23 centimeters of height). It is worth mentioning that a negative impact was seen in this variable in the treatment that consisted of the combination of mycorrhizae + organic fertilizer—this can be seen in **Figure 2**, which also shows how was the growth of the last 15 days of the test when the seedlings reached the transplant dimensions—that the increase of the best treatment (foliar organic fertilizer) was 9 centimeters. Similar results are obtained by Ramirez [7], who saw in wild piquin chilli pepper seedlings growths of 8.4 centimeters 15 days after the transplant to field in the best fertilization treatments that he tested, which was, using foliar chemical fertilizer (20-30-10).

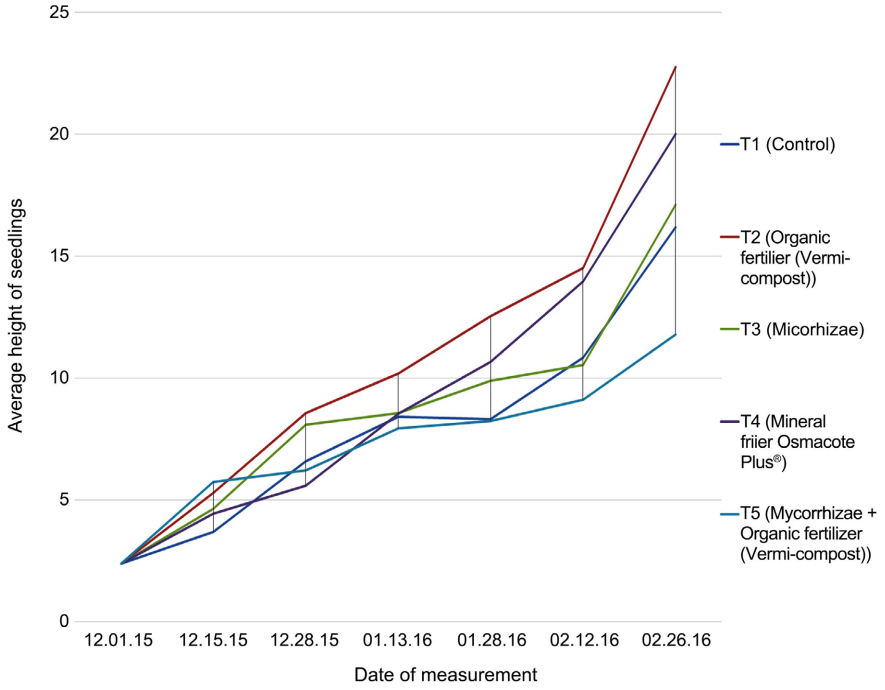

Figure 1. Average height of seedlings during the study under different fertilization treatments tested.

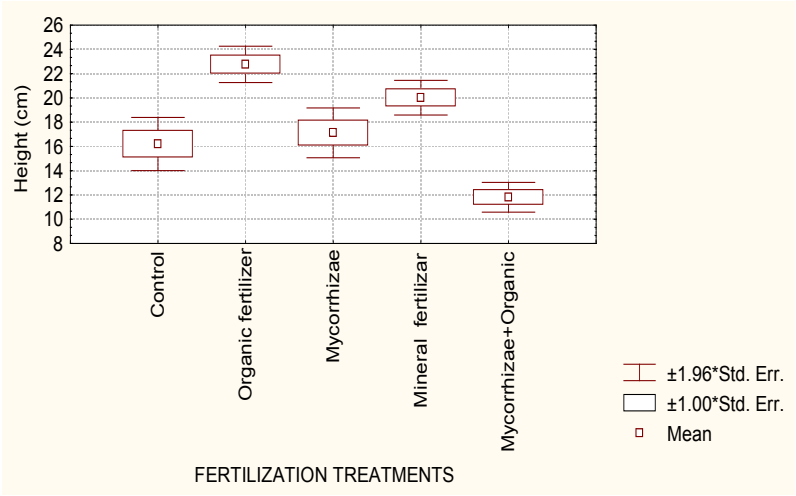

Figure 2. Final behavior of the height variable in seedlings under different fertilization tested treatments.

3.2. Number of Leaves

Figure 3 shows that the number of leaves in seedlings, treatment 2 (organic fertilizer) and treatment 4 (Osmocote Plus®) displayed a great number of leaves in each one of the dates, considerably rising every 15 days in which they were observed, being these two treatments the best ones. Likewise, it can be seen again that treatment 5 (mycorrhizae + organic fertilizer) was the treatment that had less leaves-number even with a negative effect being minor to the control.

In regard to the variance analysis made to test the different treatments of ferti-

lization, these showed significant differences: height (p = 0.0000), seedlings diameter (p = 0.000117), radical density (p = 0.000061) and seedlings coloring (p = 0.0000).

3.3. Steam Diameter

The steam diameter of seedlings was seen affected positive and negatively by the fertilization systems tested, resulting the organic fertilizer (vermicompost) being the best one applied foliar, the control showing a minor diameter, as it can be analyzed in Figure 4.

3.4. Radical Density

The radical density variable of the chilli seedlings was higher with the application of the organic fertilizer in foliar. Chaimsohn [11] mentions that the fine root density in palm seedlings that received organic fertilizer was 3.97 times greater than in those that where under chemical fertilization and chemical-organic, the same can be seen in chili seedlings that were nourished with organic fertilizer (vermicompost), as it can be confirmed in Figure 5.

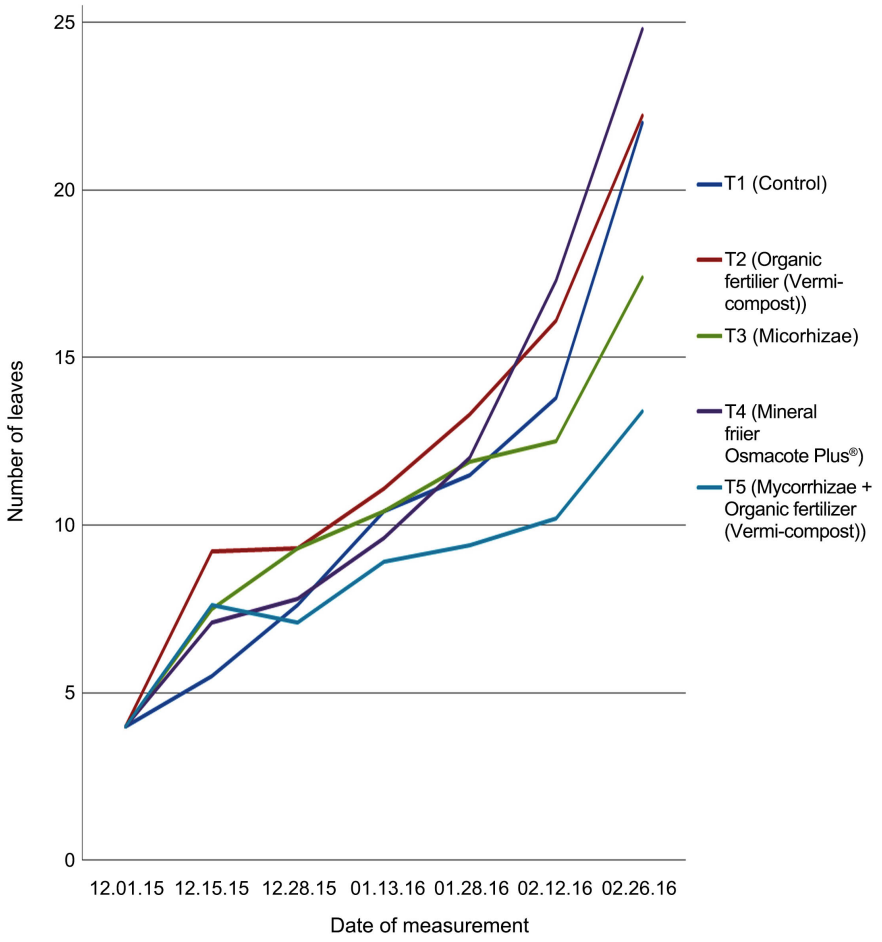

Figure 3. Number of leaves of the seedlings during the study period under the different fertilization tested treatments.

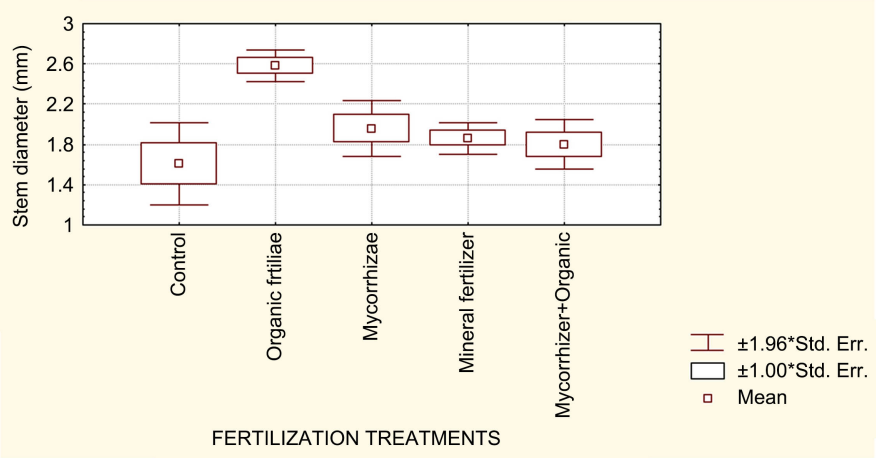

Figure 4. Final behavior of the stem diameter in seedlings under different fertilization treatments.

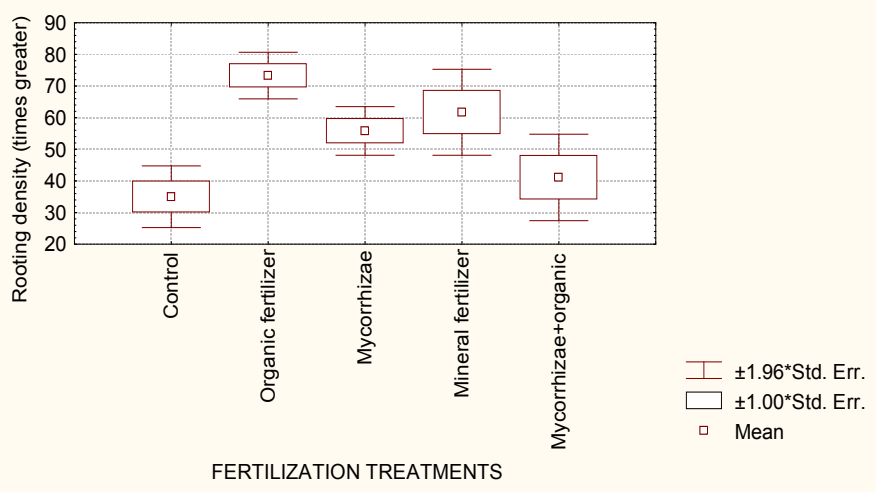

Figure 5. Statistic behavior of treatments used in much as rooting density.

3.5. Color of the Seedlings

The study output results indicate that, referring to the color of the seedlings variable, the fertilization treatments with which the seedlings achieved the maximum level (5) were the organic fertilizer (vermitcompost), and Osmocote Plus®, this can be seen in **Figure 6** and contrast with other tested treatments.

The present investigation found out that the organic fertilizer and the mineral fertilizer (Osmocote Plus®) displayed outgoing results in behalf the quality of the seedlings; (height of the seedlings by 3 months of being transplant used in the containers), steam diameter, radical density and foliage coloration. Being these results a very valuable information to the producers of wild piquin chilli pepper given by the difference of costs of the fertilizers. Conversely, regarding the use and efficiency of the mineral fertilizer, Ramirez [7] in his investigation concluded that the slow-release fertilizer (Osmocote Plus®) did not have higher effects in the performance of the wild piquin chilli pepper seedlings. This author

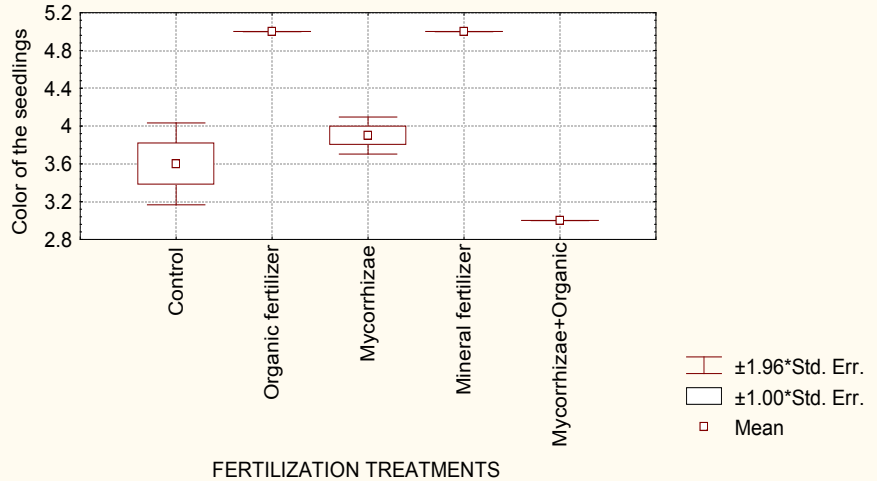

Figure 6. Observed situation of the seedlings coloration, where the best coloration has a value of 5 and the most deficient a value of 1.

mentions that mycorrhizae (*Glomus intraradicens*) altogether with the application of an inorganic foliar fertilizer (triple 20-20-20) was superior in the seedlings that just had the mycorrhizae fungus inoculated, and in this investigation the combination of the foliar organic fertilizer and the mycorrhizae to the roots did not have good results. In all likelihood, this investigation should have tested an inorganic fertilizer with the organic one as well.

As it is mentioned by Aviles [12], there are various factors that determine the productive potential of determined species of economic interest and one of them is the adequate nutrition that it is given. They also reported, for habanero pepper, an increase in height on a concentration of 35% and another one of 70% with heights of 70.1 and 75.5 centimeters respectively with a solution, quoted by themselves.

Comparatively in the present study a concentration of 20% of the organic fertilizer was used in order to obtain the best results in growth and seedlings diameter of wild piquin chilli pepper.

4. Conclusion

The best fertilizer, in the first three months of seedlings development, regarding the tested variables (*i.e.* seedlings height, stem diameter, radical density, and foliage color) was the organic fertilizer (vermicompost) applied as foliar, followed by the mineral fertilizer Osmocote Plus®, preceded by the mycorrhizae application, followed by the control, and with the lowest results displayed, the combination of the mycorrhizae and organic fertilizer.

Conflicts of Interest

The authors declare no conflicts of interest.

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