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Original Research Article

Agro-Morphological Response of Three Tomato (*Solanum lycopersicum* L.) Genotypes to CAFCOOP Products in the Nursery and Field Conditions

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Abstract: Tomatoes are grown using chemical or organic fertilizers, which influence their quality at harvest. The study aimed to evaluate the agro-morphological and germinative characteristics of three tomato genotypes under CAFCOOP products. The Nadira F1, Rio grande and Roma savanna genotypes tested for their reaction to the effect of the CAFCOOP Ltd product were obtained from the Mfoundi market (Yaoundé). Germination time, emergence of seedlings and first leaf outline, number of secondary roots and stem development were counted manually at the nursery. In the field, a caliper was used to measure plant stem, while a graduated ruler was used to measure root length and plant height. The number of secondary roots, branches and plants were counted manually. The results obtained showed significant genotypic variation in all agro-morphological traits. The number of roots varied from 14.15 ± 2.8 to 22.46 ± 3.53 for Roma, from 10.38 ± 1.89 to 24.71 ± 3.69 for Nadira F1 and from 14.62 ± 2.99 to 24.38 ± 3.47 for Rio grande, for chemical and organic treatments respectively. Plant stem diameter ranged from 5.15 ± 1.14 mm to 9 ± 0.46 mm for Nadira F1 and Rio Control, with no significant difference between treatments. The number of branches per plant, with no significant difference between treatments, ranged from 11.50±3.83 to 17.95±2.98 for Nadira F1 and Rio grande. Our study has enabled us to gain a better understanding of the positive effect of organic products on tomato production.

Keywords: organic fertilizers, Tomatoes, *Solanum lycopersicum* L., CAFCOOP Products.

1. INTRODUCTION

According to the FAO, tomato is the most important vegetable for human food, whose production remains dependent on the quality of the nursery (FAOSTAT, 2018). It is a dietetic food, very rich in water (93-95%) and very low in calories (17 kcal per 100 g). It is rich in mineral elements, vitamins (A, C and E) and Carbohydrates ranging from 2 to 3% (consisting mainly of fructose and glucose) (Souci et *al.*, 2008). Ellinger et *al.*, (2006) have shown that tomato has a positive effect against several forms of cancers such a prostate and cardiovascular diseases. These positive effects are probably the main reason for the increase in tomato production. However, this production is subject to numerous post-harvest losses. In this specific case, a significant reduction in losses is not only beneficial to all agricultural and food chains, but will also strengthen the various components of food security, namely: food availability, food accessibility, stability of market supplies, sanitary and nutritional quality of food, and environmental preservation (Ngameni et *al.*, 2017). Suh et *al.*, (2005) demonstrated that Tomato production in Foumbot, Cameroon suffers a great set back from fungal infection (blight). This Cleary explains why the local production of tomato estimated 12,286Kg/ha is much lower than the mean world value (33,988kg/ha) (Faostat,

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2014). Martin et *al.*, (2017) showed that the farmers should be encouraged to respect agronomic techniques and adopt novel innovations and farm technologies. Such techniques included the use of fertilizers and improved varieties from specialized research centers as used by Cameroon Famer Cooperation (CAFCOOP Ltd).

Tomatoes are grown using either chemicals or organic fertilizers to increase soil fertility and control losses. The quality of tomatoes at harvest is influenced by the fertilization system (Toor et *al.*, 2006). The effect of organic substances on the production and quality of tomatoes have been sufficiently demonstrated (Fatimah et *al.*, 2016; Terna and Simon, 2017; Hriska and Plamena, 2017). Organic tomato production is greatly important for people's health, compared to chemical production. However, increase tomato productivity under organic substances, tends to neglect the contribution of the plant genotype, which plays an important role in the yield and production of quality food in the final product (Lecompte and Causse, 2014). Furthermore, it is clear that yield is influenced by the genotype (Van der Ploeg et *al.*, 2007). This paper aims to evaluate the agro morphological performances of three tomato genotypes under CAFCOOP Ltd products.

2. MATERIELS AND METHODES

2.1 Site location

The study trial was carried out from August to November 2017 at CERES center in Yaoundé, Cameroon. Yaoundé is located in the southern zone of the Centre region of Cameroon, between 3°58'-5°00'N longitude and 10°27'-10°38 E latitude. Yaoundé has a tropical climate with annual rainfall estimated to 1727 mm.

2.2 Plant material:

Seeds of *Nadira F1 (Hybrid), Rio grande* and *Roma savanna* (composites) genotypes were obtained from the Mfoundi market (Yaoundé). They were tested for their response to the effect of CAFCOOP Ltd products compared to the chemical treatment usually used by farmers in Cameroon.

2.3 Biological and chemical material:

The CAFCOOP Ltd product included fungicide, insecticide, soil Fertilizer and plant growth control. The composition of those products are indicated on Table 1. The chemical products included: NPK (20-10-10) fertilizer and protective treatment done with MONCHAMP 70WP usually used by farmers in Cameroon.

Table 1: Characterization of products used by Cameroon Famer cooperation (CAFCOOP Ltd)

Product Names	Chemical compositions	Expected effects on the plant	Quantity used in 15 Liters
Topcop	50% Soufre + 8.4% tribasic copper oxide	Fungicide	30 mL
X-Cyte	Cytokynines – 0.04%	Raising seed dormancy	20 mL
Root Feed	Ca^{2+} - 7% ; N - 9% ; Mg^{2+} - 1.5%.	Growth, fruit firmness, prevents flower drop	100 mL
Golden Pest Spray Oil	Soybeans oil (food Grade)	Insecticide	75 mL
Harvest More 10-45-10+Te	$N-P_2O_5-K_2O$,	Flower Trigger	1 teaspoon
Harvest More 30-10-10+Te	$N-P_2O_5-K_2O$	Plant Growth	1 teaspoon
Harvest More 5-5-45+Te	$N-P_2O_5-K_2O$	Fruit magnification	1 teaspoon
Nitro Plus 18	Ca^{2+}- 7% ; N - 18% ; Mg^{2+}- 1.5%.	Growth	75 mL
X-TRA Power	Mg^{2+}- 0.8% ; Cu^{2+}- 0.8% ; Mn^{2+}- 0.8% ; Zn^{2+} - 3.2%.	- Soil temperature controller - Plant Growth.	60 mL
Supercharge DF70	Humic acid 70%	Stimulates growth, improvement and water retention in the plant	1/2 teaspoon

2.4 Methodology:

In order to lift the dormancy, the seeds (2.5 g for each variety) were soaked for 24 hours in a solution containing 2 ml of X-CYTE, 8 mL of X-TRA power, and an antifungal agent Top-coop, at a rate of one teaspoon. The plot underwent an antifungal treatment using SUPERCHARGE DF70 before setting up the nursery, according to the manufacturer's protocol. Mulching followed the spreading of test (soaked) and control (unsoaked) seeds in the nursery.

Transplanting and field maintenance

The soil was stirred with the hoe to obtain a homogeneous soil with about 4 cm depth. Immediately after placing the young plants, each block received manure 1 m between the columns and 0.5 m between the rows. For the test block, the plants removed from the nursery were dressed before undergoing root treatment by dipping it in a solution of TOPCOP before transplanting.

On the 22nd day after germination, tomato seedlings (3 to 4 leaves) from the test plot to be used for transplanting seeds, were treated with TOPCOP (20 mL), X-TRA power (20 mL), GOLDEN PEST (25 mL) and ½ teaspoon of SUPERCHARGE DF70. However, the control plot did not received treatment.

After transplanting, the biological treatments were sprayed at a frequency of 7 days. These treatments consisted of GOLDEN PEST SPRAY OIL and TOOPCOP used as insecticide and a fungicide respectively according to the manufacturer's protocol. Fertilization was done with NITRO PLUS 18, HARVEST MORE 30-10-10 +TE, SUPER CHARGE DF 70, HARVEST MORE 5-5-45 + TE. Flowering was stimulated and maintained with ROOT FEED, X-TRA POWER, HARVEST MORE 10-45-10 +TE and X-CYTE.

In addition, the plants in the control plot were treated at the same rate with the chemical fertilizer ADER (NPK 20-10-10) until the end of the harvest as in COLEACP (2011). The protective treatment was done with MONCHAMP 70WP.

2.4 Data collection and analysis:

Germination time, emergence of seedlings and first leaf outline, number of secondary of roots and stem development was manually counted at nursery. In field, caliper was used for measuring of the stem of plant and fruit diameter, whereas a graduated ruler was used for measuring root lengths and plant heights. An electronic balance was used to measure fruit weight. The number of secondary roots, branches and number of plant where manually counted.

Data obtained from 20 plants of each elementary block chosen randomly were subjected to analysis of variance (ANOVA) at 5% probability, using R software version 3.00. Significant differences were estimated using the Student's t test.

3. RESULTS

3.1. Varieties response in the nursery conditions

Germination time and Seedling emergence

The result shows that Germination time varies among genotypes and treatments between genotypes ranged to 3 to 5 days for Rio grande and Rio grande (control) test respectively (Table 2). Seedling emergence varied from 4 to 7 days among genotypes and treatments (Table 2).

Draft of the first leaves

The results at the time taken to draft the first sheets show that it varies from 8 to 13 days. The Rio grande (control) variety had a lower delay, while the delay is higher for the Nadira F1 control variety (Table 2). The analysis of variance shows a significant difference between treatments for this germinative parameter at (p = 0.30).

Table 2: Results of germination test, emergence and first leaf outline

varieties Tested parameters (days)	Rio grande test	Rio grande (control)	Roma test	Roma (control)	Nadira F1 test	Nadira F1 (control)
Germination Time	3	5	4	5	4	4
Time required to raise the seedling	4	6	5	7	6	6
Delay in drafting the first sheets	8	10	10	12	10	13

Development of Secondary roots per plant

The number of roots ranged from 16.62 ± 2.90 to 22.46 ± 3.53 for the biological treatment and from 10.38 ± 1.89 to 14.62 ± 2.99 for the control 22 days after planting. Regardless of the treatment, analysis of variance have shown a significant difference (p = 0.10) between varieties and between treatments. The variety Roma savana with the highest number of roots was significantly equal to the variety Rio grande and different from the variety Nadira F1.

In contrast, the number of roots per plant ranged from 17.21 ± 2.36 roots to 24.71 ± 3.69 after planting without significant difference (p = 0.35) between varieties (Table 3).

Stem development

The stem ranged from 7.15 ± 0.9 cm to 18.77 ± 2.42 cm, with an average of 11.97 ± 2.61 cm 22 days after planting. A significant difference between varieties was observed (p = 0.003) (Table 3).

Thirty days after planting, the value of stem lengths ranged from 15.5 ± 1.45 cm to 28.38 ± 3.64 cm, with a mean value of 21.26 ± 8.9 cm.

The variety Nadira F1 had the lowest value and a significant difference (p = 0.02) between varieties was founded. The effect of the biological treatment was perfectly marked on all varieties, compared to the control plot (Table 3).

Table 3: Effect of genotype and biological treatment on the number of secondary roots per plant in the nursery. TB: biological treatment

Varieties	22th date		**30th** date	
	T B	Control	T B	Control
Number of secondary roots per plant in the nursery				
Rio grande	21.77 ± 3.36^{a}	14.62 ± 2.99^{b}	24.38 ± 3.47^{bc}	18.46 ± 3.13^{d}
Roma savana	22.46 ± 3.53^{a}	14.15 ± 2.8^{b}	23.15 ± 4.30^{ab}	17.21 ± 2.36^{d}
Nadira F1	16.62 ± 2.90^{b}	10.38 ± 1.89^{c}	24.71 ± 3.69^{a}	19.36 ± 3.59^{cd}
Stem development				
Rio grande	16.23 ± 1.88^{b}	18.77 ± 2.42^{a}	28.38 ± 3.64^{a}	21.076 ± 3.59^{bc}
Roma savana	11.46 ± 1.89^{c}	11.08 ± 1.26^{c}	22 ± 3.14^{b}	19.07 ± 3.65^{c}
Nadira F1	7.15 ± 0.9^{d}	7.15 ± 0.80^{d}	22.07 ± 1.64^{b}	15.50 ± 1.45^{d}

3.2. Effect of genotypes and treatments in the field conditions

Flower swarming

Swarming was pronounced on Nadira F1, where no significant difference was noted between treatments. This result remains similar to the Rio grande variety with the lowest number of swarms. On the other hand, a significant difference between treatments was noted for the variety Roma. The control treatment showed a large number of swarms in contrast to the test treatment (Figure 1). A significant difference was observed between varieties. The variety Nadira F1 had the highest number of swarms in contrast to the variety Rio which had the lowest number of swarms.

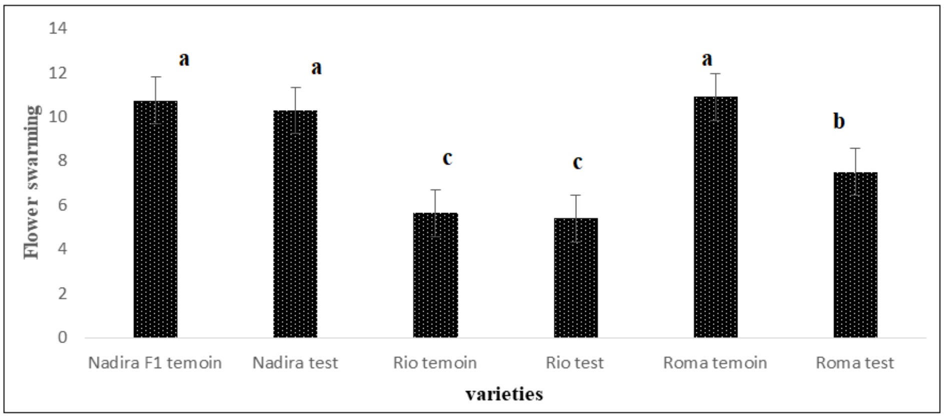

Figure 1: Combined effect of variety × treatment on flower swarming

Stem Diameter of the plants

Mean values for the diameter at the collar of tomato plants range from 5.15 ± 1.14 mm to 9 ± 0.46 mm, with a mean of 6.75 ± 1.48 mm. The Rio variety has the highest value compared to the other varieties. The analysis of variance shows no significant difference between treatments for this variety. This result is identical to that observed for the variety Nadira F1, which has the lowest value. Conversely, within the variety Roma, there is a significant difference between treatments (Figure 2).

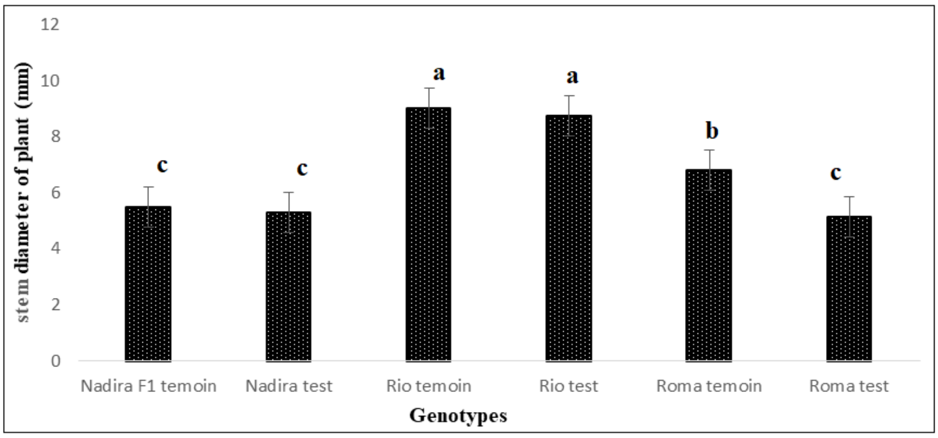

Figure 2: Combined effect of variety × treatment on collar diameter

Number of branches per plant

One month after transplanting, the number of branches per plant within varieties ranged from 11.50 ± 3.83 to 17.95 ± 2.98. The variety Rio grande had the highest number (17,55 ± 2,98[a]) of branches compared to Nadira F1 which had the lowest number of branches. However, the analysis of variance shows no significant difference between treatments. On the other hand, there was a significant difference (p = 0,81) between varieties (Table 4).

Diameters of mature fruit

At harvest, the results showed that the fruit diameter ranged from 14.03 ± 0.92 cm to 15.09 ± 1.54 cm with a mean of 14.57 ± 2.34 cm and without significant difference (p = 0.52) after analysis of the combined effects of the variety × treatment on fruit diameter (Table 4).

Fresh weight of mature fruit

Analysis of the combined effects of variety × treatment on fresh fruit weight at harvest showed that fresh weight ranged from 56.15 ± 10.24 g to 66.82 ± 19.06 g. There was no significant difference (p = 0.72) (Table 4).

Table 4: Statistical results of the combined effect of variety × treatment on number of branches per plant, diameter and Fresh weight of fruit at harvest

Tested varieties	Biological treatment	Chemical treatment
Number of branches per plant		
Rio grande	17.55 ± 2.98[a]	17.95 ± 2.98[a]
Roma savana	15.55 ± 8.54[ab]	17.35 ± 5.16[a]
Nadira F1	11.50 ± 3.83 [c]	12.45 ± 2.54[bc]
Diameters of mature fruit		
Rio grande	14.06 ±1.99[a]	14.03 ± 2.03[b]
Roma savana	14.03 ± 0.92[a]	14.36 ± 1.42[ab]
Nadira F1	15.07 ± 1.54[a]	14.99 ± 1.64[a]
Fresh weight of mature fruit		
Rio grande	56.15 ± 10.24[a]	61.00 ± 19.6[a]
Roma savana	57.78 ± 9.72[a]	56.46 ± 11.35[a]
Nadira F1	66.82 ± 19.06[a]	65.32 ± 17.20[a]

4. DISCUSSION

The analysis of results showed that treating the seed with organic products reduces the germination time by 3 days for the Rio grande variety and 4 days for the other two varieties, as well as the seedling emergence time. This time taken by the seeds in the nursery to germinate is different from the average time of 6 to 8 days found by VAN Der Vossen et *al.*, (2004). It can be concluded that the biological treatment allows to lift the dormancy of the seeds and to reduce the germination time by 3 to 5 days depending on the varieties tested. This result corroborates that of Mok et *al.*, (2000), who demonstrated that cytokines promote seed germination.

Root growth and development parameters showed that the secondary roots of the plants in the test plots were more numerous. But the analysis of the combined effects of treatment type × variety showed that there were no significant differences in the number of roots between varieties and treatments. Regarding the result obtained, these results, being identical to those of the plants at the 30th day of growth, confirm the non-use of organic products regardless of the variety at the first stage of growth of tomato plants in the nursery.

In the field conditions, Rio grande treated with organic products produced early flowers (less than 3 weeks after transplanting). This earliest production of flowers may be due to the effect of harvest more a trigger for flowering on the one hand and the effect of genes on the other hand. This clearly justifies the flowering delay observed with the other varieties whose effect has been significantly demonstrated in this study. This effect is in accordance with the findings of Boteva and Yankova (2017) who found a positive effect of bio-products on the early yield of tomato varieties.

The stem diameter is not influenced by the type of treatment within the variety. This result is different from that of (Mensah et *al.*, 2019) on the tomato variety "Padma" which does not have significant difference in crown diameter. However, there is a significant difference between genotypes. The same significant difference was observed between varieties for fruit weight. Only the mean weight obtained would be close to those found by some authors, although the mean weight of fresh fruits in the organic plot was approximately equal to that of the synthetic plot. This could be explained by the fact that these fruits of the Nadira F1 variety have the property of storing a lot of water.

In summary, organic products contribute to the improvement of morphological parameters (number of roots and development of stems) and tomato production plants compared to chemical products. These observations are contrary to those of Kochakinezhad et *al.*, (2012) who showed that the difference between organic and chemical fertilizers was not significant when he recommended the use of chemical fertilizers, or those of Ghorbani et *al.*, (2008) who showed that chemical fertilizers offered a good yield compared to organic fertilizers consisting of cattle, sheep and poultry manures, green-waste and household composts. However, HRISKA and PLAMENA (2017) clearly demonstrated that, Bio-product has stronger effect – 47.7% in yield for variety.

Moreover, for the parameters such as number of roots, stem development, flower swarms, diameter at the collar, number of branches per plant, a significant difference was observed between varieties. This demonstrates the genetic control of these parameters. This result corroborates that of Fatimah et *al.*, (2016), which showed that tomato varieties acted differently under the effect of organic substances.

5. CONCLUSION

We studied the agro-morphological and germinative parameters of tomatoes genotypes under biological treatments. The results showed that biological products increases the number of roots, stem development, the swarming of the flowers, the diameter at the collar and the number of branches per plant for tomato plants agro morphological parameters, compared to chemical products. However, there is no significant effect on germinative parameters for genotype and biological treatment. Significant differences were observed between varieties for number of roots, stem development, flower swarms, diameter at the collar, number of branches per plant.

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