



The Effects of Trellising Methods on Determinate Tomato Varieties' Yield in Zimbabwe

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Authors' contributions

This work was carried out in collaboration between all authors. Author CM wrote the protocol, and wrote the first draft of the manuscript. Author MS managed the experiment and collected the data. Author GM designed the project and analyzed the results. Author KNN managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To determine the effect of trellising methods of determinate tomato varieties on fruit diameter, number of fruits per plant, marketable and total yields.

Study Design: A 3 x 4 factorial experiment in Randomized Complete Block Design with 3 replications was used

Place and Duration of Study: Mutoko district in Zimbabwe between May and October 2013

Methodology: Two factors were studied the trellising method (including staking and weave, single pole staking, caging and the ground culture as control) and the tomato varieties (Roma, Floridade and Rio Grande). The factors were studied concerning their effect on yield amount.

Results: Significant difference was found ($P \leq 0.05$) due to the trellising method, whereas the caging caused the highest results (number of fruits per plant, marketable and total yield amount). Additionally, species variability plays important role in determination of yield quality as found for Roma one as compare to the other ones Not only the trellising method alone is affecting the yield,

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but the suitability of the species to the trellising method, and the one which has the highest results was Roma when compared to Floridade and Rio Grande.

Conclusion: The caging method resulted in an increase in yield. Despite any trellising method used, trailing increases the amount of marketable tomatoes. These results, however, need further studies to validate reliability.

Keywords: Caging; marketable yield; number of fruits; single pole; staking and weave.

1. INTRODUCTION

Tomato (*Lycopersicon esculentum* L) is among the most important vegetables grown by smallholder farmers in zimbabwe. It constitutes a great amount of essential nutrients for their nourishment. They contain carbohydrates, dietary fiber, proteins, vitamins (a, b, c, k, thiamine, pyridoxine and foliates), calcium, iron, magnesium, manganese, phosphorus, potassium, carotene-b, carotene-a, zeathin and lycopene [1]. The production and marketing of the crop provides employment for a greater percentage of the rural zimbabwean population. The crop is also a source of income for the small holder farmers [2,3].

Despite the economic importance of tomatoes in zimbabwe, its production is facing with the challenges including, high production transport costs, poor marketing, pests and diseases etc. Pests and diseases in tomato production had resulted in massive reduction of yield and quality. The problem of pests and diseases has been exacerbated by failure of farmers to procure pesticides to control them. Alternatively, trellising of tomatoes can address the problem of pests and diseases. Trellising the plants is more practical and affordable by the local smallholder farmers [4]. According to saunyama and knapp [5], in mutoko and muzarabani trellising controlled red spider mites in tomato. This was attributed to improved spray penetration into lower leaf surfaces due to trellising. Trellising resulted in upright crop which improved air penetration reducing incidences of fungal disease attacks and easy maneuvering when carrying operations like spraying [6]. Trellising tomatoes also increased pollination and reduced vine damages during harvesting.

In Zimbabwe, the most common method of trellising among small holder farmers is the single pole staking. This system is labor intensive in cutting the staking poles and trellising the plants. It contributes greatly to deforestation resulting in an unsustainable production system. Also there is massive fruit and flower drop due to

shaking when tying to cater for continuous growth. Fruit disorders such as sun scalds and cat face are a problem while the fruit is been exposed to direct sunlight. There are many different trellising methods which are being used worldwide such as staking and weave, caging, wire trellising, string trellising and post and twine trellising system among others. The researchers at oklahoma state university examined the economics and performance of four different tomato training systems and their findings were that staking and weave produced better quality and yield [7,8]. There is limited information on the evaluation of these trellising methods to varieties that are commonly grown by smallholder farmers.

2. MATERIALS AND METHODS

The study was done in mutoko located in mashonaland east province of zimbabwe with 17°23'59"s latitude and 32°13'00"e longitude. The field experiment was conducted using a 3x4 factorial arrangement in randomized complete block design with three replications. The first factor was tomato varieties with the following levels, roma, floridade and rio grande. The second factor was trellising methods with the following levels: Staking and weave, single pole staking, caging and ground culture / no support system (control). In stake and weave method, wooden stakes were driven between plants, and then lines of strings between the stakes on both sides of the plants were used to support the plants. Single pole trellising involved placing stakes next to every plant 7 to 10 cm from the base of the plant on the side away from the first bloom clusters. While, caging system involved bending the wire around to make a tube or cage over each plant and fasten the ends together.

The seeds were sown in a nursery after basal dressing of 'compound d'(N_(7%), P_(14%), K_(7%)) fertilizer at a rate of 1 kg m⁻². Sowing depth was 2, 5 cm and seed were covered with sand and grass mulch. Watering was done on daily basis for 5 weeks after sowing and hardening off was done at 6 weeks after sowing by withdrawing

water gradually for one week. At 7 weeks after sowing, the seedlings were transplanted into the field. The inter-row spacing was 75 cm and in-row was 30 cm. Prior to transplanting, 'compound d' fertilizer was applied at 1333 kg ha⁻¹. At three weeks after transplanting, 'ammonium nitrate' (n34, 5%) was applied as topdressing at a rate of 222 kg ha⁻¹. The trellising of tomatoes was done one week after transplanting. The following data was documented: number of flowers per cluster, number of fruits per plant, fruit diameter, marketable and total yield. The analysis of variation was done using genstat 14th edition (<http://www.vsnl.co.uk/software/genstat/14th-edition-new-features>). "The described software and tools do not reflect the author preference". Mean separation was carried out using least significant differences at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1 Number of Flowers Per Plant

There was a significant difference ($p \leq 0.05$) between the varieties on number of flowers per plant as shown in Table 1. Floridade has the highest number of flowers per plant while rio grande and roma had the least. The differences could be attributed to genetic differences between the varieties. This is comparable to [9] who observed significant differences in number of flowers per plant between the genotypes of tomato. There was no interaction between the method of trellising and variety on the number of flowers per plant. It should be noted that differences were found but without the examined statistical confidence.

Table 1. Effects of variety on number of flowers per plant

Treatments	Flowers/plant
Floridade	15.95 b
Rio grand	12.70 a
Roma	13.40 a

3.2 Number of Fruits per Cluster

There was a significant difference between the methods of trellising on number of fruits per cluster as shown in Table 2. Caging had the highest number of fruits per cluster and was not statistically different from ground culture and staking and weave. Perhaps this may be attributed to limited exposure of flowers to sunlight due to more foliage. Single pole staking had the least number of fruits per cluster as

shown in Table 2. Diver et al. [7] noted that single pole staking is associated with more damages on foliage thereby reducing the photosynthetic area of the plant which produces food, forcing premature abscission of flowers, leaving only the fruits the plant is able to support. There was no interaction between variety and method on the number of fruits per plant.

Table 2. Effects of trellising methods on number of fruits per cluster

Treatment	Number of fruits/cluster
Caging	5.7 b
Ground culture	5.6 b
Staking and weave	5.5 ab
Single pole staking	5.2 a

3.3 Fruit Diameter

There was a significant difference between the varieties on fruit diameter. Rio grande and floridade had the highest fruit diameter while roma had the least as shown Table 3. The differences are probably due to genetic differences that exists in tomato varieties [9]. The varieties, rio grand and floridade may be sharing the same gene that controls the diameter of fruits, which may be different from roma variety.

Table 3. Effects of variety on fruit diameter

Treatment	Fruit diameter (cm)
Rio grand	7.305 b
Floridade	7.192 b
Roma	5.757 a

3.4 Marketable Yield

There was a significant difference between the treatments on marketable yield. Caging had the highest marketable yield as shown in Fig. 1a. Olson et al. [10] reported that cages keep fruit off the ground, protects them against direct sunlight reducing disorders such as sun scalding and cracking and reduces incidences of pest attacks on fruit. Ground culture had the least marketable yield and was not statistically different from single pole staking and staking and weave, probably due to exposure of fruits to direct sunlight and pest attack [7]. The results also showed that there was a significant difference between varieties Fig. 1b with roma recording the highest marketable yield. This suggests that the genetic makeup of tomato also plays a role in determining the quality of the fruits.

3.5 Total Yield

There was a significant difference between trellising methods on the total yield Fig. 1a. The caging method had the highest total yield. This was due to higher number of fruits per plant as shown in Table 1 and also reduced fruit disorders and less fruit rots as evidenced by highest marketable yield Fig. 1a. The promotion of heavy foliage in cages Fig. 2 may also have contributed to highest total yield due to more assimilates from leaves being channeled to the fruits [7].

Also roma had the highest total yield while floridade and rio grande had the least as shown in Fig. 1b. This is in agreement to what was observed where the marketable yield of roma was the highest compared to floridade and rio grande Fig. 1b. The differences are probably due to genetic variability between the varieties [11]. The varieties rio grande and floridade may be sharing the same genes since no significant differences were observed in fruit diameter and marketable yield. There was no interaction between method and variety on the total yield.

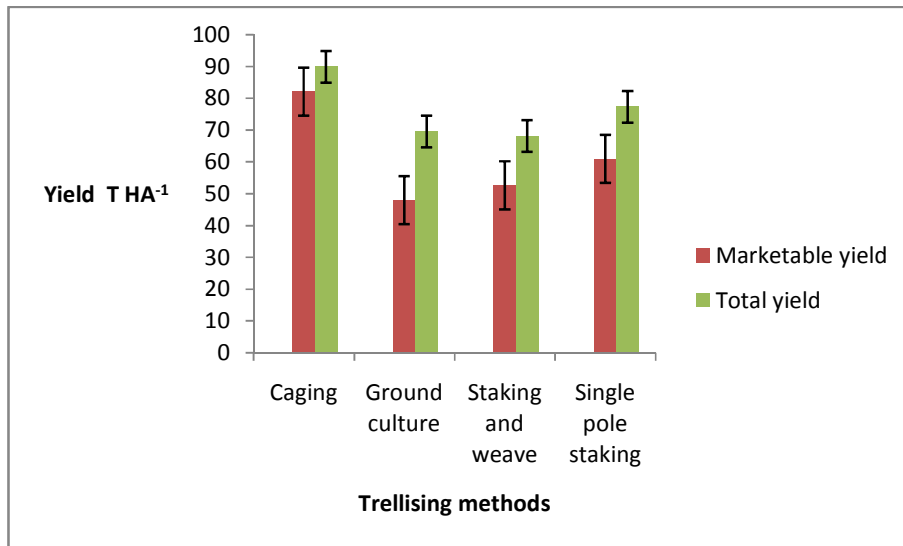


Fig 1a. Effects of trellising method on marketable and total yields

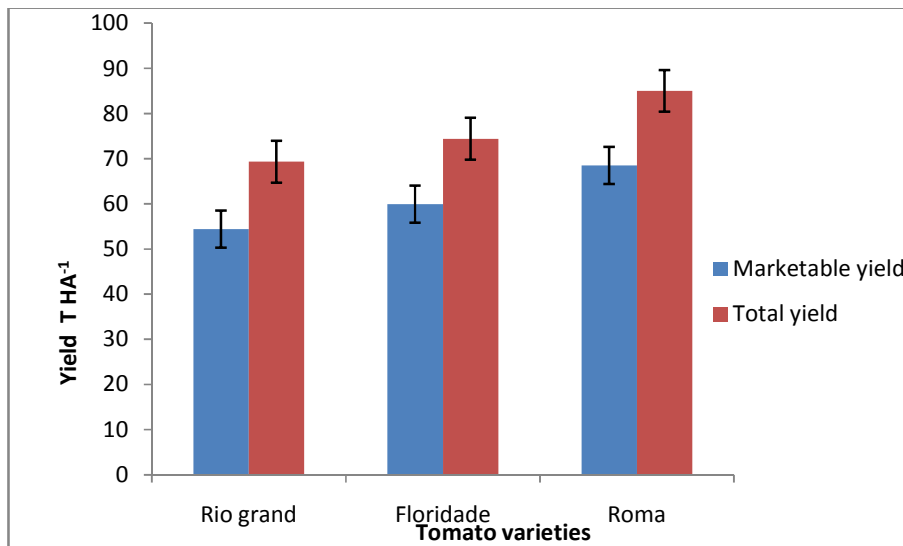


Fig. 1b. Effects of tomato variety on marketable and total yields



Fig. 2. Cage trellising method of tomato

4. CONCLUSION

The caging trellising method resulted in an increased number of fruits per plant, highest marketable yield and lowest unmarketable yield. Despite any trellising method used, trailing reduces the yield of unmarketable fruits. Single pole; and staking and weave trellising methods are not recommended when the objective is to increase the quality of tomatoes since they resulted in low marketable yield.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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