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Evaluation of Improved Tomato (*Lycopersicon esculentum Mill*) Varieties for Fruit Yield and Yield Components under Irrigated Condition in Lowland Area of South Omo Zone

Awoke Tadesse*

Department of Plant Agronomy Research, Jinka Agricultural Research Center, Jinka, Ethiopia
***Corresponding author:** Awoke Tadesse, Department of Plant Agronomy Research, Jinka Agricultural Research Center, Jinka, Ethiopia, E-mail: Awoketadese3@gmail.com

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ABSTRACT

Tomato is one of the most important and widely grown vegetables in Ethiopia. However, the productivity of the crop in the study area is challenged by the shortage of improved varieties. To alleviate this problem the field experiment was conducted two consecutive years during the 2019 and 2020 growing seasons to evaluate improved tomato varieties for fruit yield and yield components. Six improved tomato varieties (Chali, Fetene, Cochoro, Gelilema, Melka salsa, Melka shola) and one local were evaluated in randomized complete block design in three replications. Days of 90% maturity, plant height, number of fruit per plant, fruit weight per plant, number of clusters per plant, number of fruit per cluster, fruit polar and equatorial diameter and fruit yield were collected and subjected to analysis of variance using SAS software program. The combined result of the study revealed that there was a significant difference among varieties in all traits except plant height, the number of fruit per cluster and fruit equatorial diameter. The highest (40.71 ton ha^{-1}) fruit yield was recorded from Chali variety with 97.3% fruit yields increment as compared to the localvariety. Therefore, the use of Chali variety can be recommended at the Weyito location and its vicinity.

Keywords: *Evaluation; Tomato; Varieties; Fruit yield*

Introduction

Tomato (*Lycopersicon esculentu Mill*.) belongs to the family Solanaceae and is one of the most popular, important edible and nutritious vegetable crops in the world (Meseret et al., 2012) [1]. Central and South America are believed to be the origin of the crop. It became distributed to Europe and Asia in the early and mid-1960s. The crop spread *via* traders to Egypt, Sudan, South Africa, and West Africa and to the rest of the world (Asfaw and Eshetu, 2015) [2]. Tomato is a vital source of carbohydrates, minerals, sugars, amino acids, vitamins (especially vitamin B and C), Phosphorus and dietary fibers (Naika et al, 2000) [3]. Most parts of the world produce and consume tomatoes from the home gardens and greenhouse to the larger commercial farms as it can various agro-ecological conditions (Agyeman et al., 2012) [4]. China is the world's leading producer of tomatoes with an annual production of more than 30 million tons and followed by United States, India, Turkey, Egypt, and Italy, respectively (FAOSTAT, 2010) [5].

In Ethiopia, tomatoes can be consumed in raw, ingredients in many dishes, salads, sauces and drinks. It is an important ingredient of diet for the majority of people in almost every household. It is also among the most economically important vegetable crop (kitila et al. 2012) [6]. The total production and productivity in Ethiopia are far below that the world and major African producers. According to CSA, (2019) reported that the area coverage by tomato was around 4,322.31 ha with the production of 23, 583.8 tones and productivity of 5.12 ton ha^{-1} that is far below average world production and productivity (FAOSTAT. 2011) [7,8]. Tomato is a widely grown vegetable crop in Ethiopia. The total production of tomatoes in Ethiopia has shown a marked increase recently, indicating that it became the

most profitable crop providing a higher income to small-scale farmers compared to other vegetables besides the low production and productivity (Lemma, 2003) [9]. Though adapted to wider agro eco climate conditions, tomato prefers a temperature of 20°C-27°C for better fruit setting and yield and when the temperature goes more than 30°C or falls below 10°C fruit setting is very poor (Hanson et al., 2000) [10]. Likewise, researchers in the early study stated, deep well-drained sandy loam soil with a pH of 6-7 is better for the production of Tomato (Patel et al., 2012) [11]. Among many different contributing factors for the low yield and poor quality tomato product, lack of improved variety that is adapted to growing conditions and poor management practices (Yeshiwas et al., 2016) [12].

In SNNP region, it has an economically important place among other vegetable crops due to ease of production, high profitability per unit area and increase in small-scale irrigation schemes, the area underproduction of the tomato is increasing from time to time. Tomato was grown on about 598.13 ha in SNNP Region from which about 6,161.19 tons onion yield was produced with the average zonal yields 1.03 t ha^{-1} (CSA, 2019) [7]. However, this fruit yield is far less than the attainable yield (30.6-76.7 t ha^{-1}) under good management conditions (MOANR, 2017) [13].

Several production problems make the farmers not produce tomatoes in an advanced manner. Among that production problem the low yield because of lack of improved varieties, non-optimal agronomic practices, the prevalence of diseases and insect pests. The success of vegetable production in general and tomato, in particular, is mainly dependent upon the selection of appropriate varieties for a particular location. In the last few decades, several high-yielding varieties and hybrids have been developed and recommended by different agricultural research centers in Ethiopia. However, the yield potential, productivity and quality need to be tested under various agroecology and climatic conditions like the south Omo zone. Moreover, improved tomato varieties are limited in South Omo Zone and farmer/agro-pastorals using their local cultivars, which result in them produced low yield per hectare (Misgana et al., 2017) [14]. Therefore, to alleviate this problem, the experiment was conducted to identify superior tomato variety/ies under irrigation conditions for increased production and productivities in the study area.

Materials and Methods

Description of study area

A field experiment was conducted for two consecutive years during (2019 and 2020/21 G.C) at Weyito in Benntsemay woreda. Weyito is located South Omo zone in Southern nations, nationalities and people's regional state. It is situated between 5°01'-5°73' North latitude and 36°38'-37°07' East longitude with an altitude of 588 meters above sea level. The rainfall distribution of the area is bimodal with the main rainy season extends from January to May and the second cropping season, from July to October. It receives an annual average rainfall of 876.3 mm and the monthly average minimum and maximum temperatures of 18.2°C and 37.3°C, respectively. All the metrological data given above for the two locations are long-term averages.

Experimental treatments and design

Six improved tomato varieties namely: Chali, Gelilema, Melka salsa, Melka shola, Cochoro, Fetan were obtained from Melkassa agriculture research center and one local check variety from the local market were used for the current study. These varieties were arranged in a Randomized Complete Block Design (RCBD) with three replications.

Management of experimental field

The land was ploughed, disked, harrowed and ridged with 1 m by labor. A seed was sown in a nursery on a well-prepared seedbed. Seedlings were planted on fine soil which was prepared following the recommended tillage practice for the crop. The undamaged and uniform medium-sized seedlings were carefully transplanted after 6 weeks to the experimental plots of 4 m × 4 m dimensions on ridges of the furrow spacing of 1 m between furrows and 30 cm between rows on the ridge. The replications and plots were separated by 2 m. Fertilizer rate of 150 kg/ha of NPSB was applied at transplanting and half of urea which is 75 kg/ha was applied at transplanting and the remaining half of urea (75 kg/ha) was applied six weeks or 45 days after transplanting. The irrigation water was applied by used furrow irrigated at every 6 days-8 days from planting up to flowering and then every 10 days up to physiological maturity according to weather condition by using the furrow method. All other agronomic practices (weeding, cultivation, stacking and pesticide) were applied uniformly to all plots. The two rows were harvested when 80% of the fruit turned yellow and top fall attaining the full size of bulbs and then cured for a day.

Data collected

Five randomly selected plants were used from the central two rows for all treatment before flowering to record quantitative data measurements such as: Plant height (cm), number of primary branches, fruit per plant, number of fruit cluster per plant, fruit polar diameter (cm), fruit equatorial diameter (cm), total fruit weight per plant (kg) and two rows four consecutively times were harvested fruit yield then later converted to ton per hectare.

Statistical analysis

The collected data were subjected to Analysis of Variance (ANOVA) appropriate to factorial experiment in a Randomized Complete Block Design (RCBD) using SAS software program version 9.2 (SAS, 2008) with a Generalized Linear Model (GLM) procedure. Means were separated using the Least Significant Differences (LSD) test at 5% level of significance.

Results and Discussion

Days to physiological maturity

In this study, combined analysis of variance showed the main effect of varieties highly significant (P<0.001) effect while there was no significant difference between the interaction varieties with the growing season on days to maturity (Table 1). Significantly more days (91.08) to physiological maturity were recorded for variety 'Chali ', while the lowest days (79.75) for variety 'Fetene' among tested varieties. This study result similar to the finding of Chernet et al. (2013) reported that the presence of sufficient variability for days to 90% maturity in tomato verities indicates the genetic variation of varieties [15].

Table 1: Mean value for crop growth and yield components parameters of tomato varieties planted at weiyto, South Omozone. MD: 90% Maturity Date; Ph: Plant Height; Number of Fruit Per Plant; TNFPP: Total Number of Fruit per Plant

	2019	2020	Combined	2019	2020	Combined	2019	2020	Combined
Varieties	**DM 90%**	**DM 90%**	**DM 90%**	**Ph(cm)**	**Ph(cm)**	**Ph(cm)**	**TNFPP**	**TNFPP**	**TNFPP**
Chali	90.33a	91.83a	91.08a	91.67b	97.1	94.38	52.0abc	54.1a	53.06ab
Gelilema	90.00a	81.50ab	90.76ab	95.0ab	92.7	93.6	42.7de	41.6bc	42.11c
Melka shola	89.66ab	91.17ab	90.42ab	103.3a	96.5	99.93	54.0ab	46.8abc	50.39ab
Cochoro	88.33b	89.83b	89.08b	91.67b	90.1	90.83	36.7e	46.4abc	41,53c
Local	85.67c	87.17c	86.42c	96.7ab	95.57	96.32	59.7a	53.7ab	56.67a
Melka salsa	82.33d	83.83d	83.08d	98.3ab	92.3	95.32	43.3cde	51.3abc	47.33bc
Fetan	79.66e	79.83e	79.75e	93.3ab	88	90.73	49.0bcd	46.0abc	47.50bc
CV%	1.2	1.17	1.08	6.35	8.06	5.61	11.37	15. 03	8.04
LSD(0.05)	1.57	1.86	1.68	10.4	13.06	5.61	9.23	12.2	10.75

Plant height at maturity

In this study, combined analysis of variance as shown in Table 1 indicates the main effects of varieties had not significantly (P<0.01) effects on plant height. Although there was no significant difference between tomato varieties, slightly the highest (99.93 cm) and lowest (90.73 cm) plant heights were obtained from Melka shola and Fetene varieties, respectively. However, this study result was in line with the finding of Chala et al. (2020) who obtained that, statistically similar in their plant height among tomato varieties that studied in west Shewa zone, Ethiopia [16].

Total number of fruits per plant

Primary branches were highly significantly (P<0.05) affected by the main effects of variety; however, their interaction of variety with growing season did not show a significant effect. The combined result showed that the highest total number of fruits per plant (56.67) was obtained from a local variety and the lowest (41,53) total number of fruits per plant was recorded from Cochoro variety (Table 1). The difference in the total number of fruits per plant among the varieties could be most probably due to the existence of dissimilarity in genetic composition among them, for that

fact characters may differ in their genetic properties to response formation of fruit. Many authors such as Emami et al. (2013) (33-79), Abdelmageed and Gruda (2009) (17.16-50.7) reported a wide range of differences in the number of fruits per plant in tomato genotypes [17,18].

Fruit weight per plant (kg)

Fruit yield per plant was the highly significant effect ($p<0.01$) by the main effect of variety while didn't significantly affect by the interaction effect of variety and growing season. The highest fruit yield per plant (2.1 kg) was scored from Chali variety and the minimum (1.18 kg) was recorded from local). This is in line with the finding of Saleem et al. (2013) who found the highest fruit yield per plant (2.48 kg) for 30 tomato genotypes evaluated. Similarly, Chernet et al. (2013) reported the highest fruit yield per plant (2.10 kg) for 36 tomato genotypes [15,19].

Number of fruit clusters per plant

The number of fruit clusters per plant was significantly ($p<0.001$) affected by the main effect of the varieties while their interaction variety with growing season was not significantly influenced.

The combined mean value result showed that, the highest number of fruit clusters (22.83) were recorded from Melka shola variety and the minimum (12.17) were recorded from by Melka salsa variety (Table 2). The present study was in agreement with the findings of Yeshiwas et al. (2016) who obtained a significant difference in the number of fruit clusters per plant of tomato varieties.

Table 2: Mean value for yield components parameters of tomato varieties planted at Weyito, South Omo zone. TWFPP: Total Fruit Weight per Plant; NFCPP: Number of Fruit Clusters per Plant; NFPC: Number of fruit per cluster.

	2019	2020	Combined	2019	2020	Combined
Varieties	**TWFPP (kg)**	**TWFPP (kg)**	**TWFPP (kg)**	**NFCPP**	**NFCPP**	**NFCPP**
Chali	1.95a	2.25a	2.1a	15.3c	17.6b	15.83b
Gelilema	1.25b	1.55b	1.40b	16.3c	17.3b	16.83b
Melka shola	0.98b	1.45b	1.23b	22.3a	22.8a	22.83a
Cochoro	1.83a	2.13a	1.98a	16.7bc	16.3bb	17.17b
Local	1.17b	1.41b	1.18b	18.7b	12.3c	16.17b
Melka salsa	1.27b	1.56b	1.42b	12.0d	13.7c	12.17c
Fetene	1.15b	1.45b	1.3b	16.0c	17.0b	16.50b
CV%	18.85	12.66	16.78	7.33	5.22	5.81
LSD(0.05)	0.45	0.39	0.37	2.04	1.91	1.75

Fruit polar and equatorial diameter (cm)

Fruit polar diameter was highly significantly affected ($p<0.01$) by variety, while was not scientifically affected by the interaction of varieties with the growing season, on the other hand, there was no significant difference in tomato fruit equatorial diameter between the two years (Table 3). Variety Chali gave the highest (6.58 cm) fruit polar diameter at which, did not significantly differ from Cochoro while the minimum fruit polar diameter (3.95 cm) was recorded from Melka salsa variety (Table 3). This variation is ascribed to the differences in the growing environment climatic conditions and genetic make-up of the varieties. Similarly, Shushay et al. (2014) reported that fruit polar diameter was significantly different among tomato varieties [20].

Table 3: Mean value for crop yield and yield components parameters of tomato varieties planted at weytio, South Omo Zone. FPD: Fruit Polar Diameter (cm); FED: Fruit Equatorial Diameter (cm); FY: Fruit Yield per hectare.

	2019	2020	Combined	2019	2020	Combined	2019	2020	Combined
Varieties	**FPD**	**FPD**	**FPD**	**FED**	**FED**	**FED**	**FY(t ha^{-1})**	**FY(t ha^{-1})**	**FY(t ha^{-1})**
Chali	6.33a	6.8a	6.58a	6.12	6.62	6.39	39.00a	42.417	40. 71a
Gelilema	5.16bc	5.7abc	5.42ab	7	7.51	7.23	26.73c	25.7de	26.12cd
Melka shola	4.01d	4.54bcd	4.08d	7	7.52	7.23	17.92e	33.39bc	24.76cd
Cochoro	6.10ab	6.1ab	6.35a	6.43	6.9	6.66	34.44b	37.25b	35.85b

Local	4.33cd	4.5cd	4.42cd	6.66	7.11	6.89	19.32e	22.00e	20.66e
Melka salsa	4.03d	3.9d	3.95d	6.66	7.56	7.12	23.22d	22.83e	23.03de
Fetene	5.601b	6.6a	5.85ab	7.33	7.7	7.5	24.83cd	29.63cd	27.23c
CV%	11.87	11.13	11.71	10.76	9.44	9.56	5.05	8.02	6.18
LSD(0.05)	1.11	2.07	1.09	Ns	Ns	1.19	2,24	7.03	3.092

Fruit yield (t/ha)

In this study, combined analysis of variance showed the main effect of varieties highly significant (P<0.001) effect on fruit yield, while the main effect of the growing season and the interaction varieties with growing season effect were not significant (Table 3). Combined mean value over years, the highest fruit yield (40.71 t/ha) was obtained from Chali variety and followed by Cochoro (35.85 t/ha), while the least fruit yield (20.66 t/ha) was recorded from local variety. Chali variety with 97.3% fruit yields increment as compared to the local variety.

The current study was in agreement with the finding of Shushay et al. (2014) who obtained that the improved variety had a 73.86% yield increment over a local variety. Similarly, Chala et al. (2020) who obtained that, a significant difference in fruit yield among tomato varieties [16, 20].

Conclusion and Recommendations

Tomato is one of the most important and widely grown vegetables in Ethiopia. However, the productivity of the crop in the study area is challenged by the shortage of improved varieties. To alleviate this problem the field experiment was conducted two consecutive years during the 2019 and 2020 growing seasons to evaluate improved tomato varieties for fruit yield and yield components. Six improved tomato varieties (Chali, Fetene, Cochoro, Gelilema, Melka salsa, Melka shola) and one local were evaluated in randomized complete block design in three replications

Days of 90% maturity, plant height, number of fruit per plant, fruit weight per plant, number of clusters per plant, number of fruit per cluster, fruit polar and equatorial diameter and fruit yield were collected and subjected to analysis of variance using SAS software program. The combined result of the study revealed that there was a significant difference among varieties in all traits except plant height, a number of fruit per cluster and fruit equatorial diameter. From the result of the current study, the highest (40. 71 t ha^{-1}) fruit yield was recorded from Chali variety with 97.3% fruit yields increment as compared to the local variety. Therefore, the use of Chali variety can be recommended at the Weyito location and its vicinity. Therefore, it can be promoted to PED in around tested areas.

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