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Evaluation of Agronomic Performance and Lycopene Variation in Tomato (*Lycopersicon esculantum* Mill.) Genotypes in Mizan, Southwestern Ethiopia

Jiregna Tasisa Dufera

Department of Horticulture, College of Agriculture and Natural Resources,
Mizan-Tepi University, P.O. Box 260, Mizan Teferi, Ethiopia

Abstract: Twenty one tomato (*Lycopersicon esculantum* Mill.) germplasms were evaluated for agronomic performances, lycopene variability and some quality parameters to identify the genotypes having high yielding and better quality performances. The study was conducted under Mizan agro-ecology (Southwestern Ethiopia) on Mizan-Tepi University trial field during September 2011 to May 2012 using Randomized Complete Block Design with three replications. Analysis of variance showed highly significant differences among the genotypes ($P<0.0001$) for all characters evaluated. The genotypes Roma VF, Cochoro/Pace setter), Pirson, Melkashola/Red pear and Fetan/Picador showed over all superior yield and quality performances to the other genotypes, thus they could be recommended as promising varieties for production in the area. Higher genotypic and phenotypic coefficients variation values were recorded by the characters fruit clusters per plant, nodes on main stem, fruits per plant, yield per plant and lycopene content, indicating the presence of variability among the genotypes and the scope to improve these characters through selection. In general, the result indicates the presence of enough variability among the genotypes to select parents with desirable performances and combine with varieties having better lycopene contents for further genetic improvement.

Key words: Tomato · Yield · Lycopene · Genotypic Variability · Phenotypic Variability

INTRODUCTION

Tomato (*Lycopersicon esculantum* Mill.) is a popular produced and consumed vegetable crop almost all over the world. It is used as fresh and processed forms in a variety of dishes. It is an important source of vitamin A and C as well as minerals and carotenoids. Lycopene is a powerful antioxidant cartenoid naturally synthesized in tomato. It is reported by many researchers that lycopene has potential human health benefits. As reported by [1], lycopene has many human health benefits as it reduces the risks of nervous system problems, heart disease, cancer and obesity. Similarly, [2] indicated tomato lycopene, prevents from skin disease induced by UV-light. Lycopene protects from various cancers and cardiovascular disease [3]. As reported by [4], high tomato or lycopene consumption reduces the risk of prostate cancer.

In order to exploit the potential human health benefits of lycopene, it is very important to increase its production through genetic manipulation of the crops expected to be the potential source of this antioxidant compound. Leave alone; increasing the productivity of the crop through genetic manipulation, tomato production under Mizan agro-ecology is almost nearer to impossible. The evidence is that fresh tomato produces are mostly transported from nearer areas particularly Jimma to satisfy the consumption demands for Mizan town people. And this indicates unavailability of best adaptable, high yielder, high quality performing and disease resistant/tolerant tomato varieties which identified and recommended for production under this particular agro-ecology.

Hence, identification of the varieties with high potential of lycopene contents and combining with other varieties having other traits of economic importance is the first step in breeding strategy to develop varieties with traits of high yielding and high quality. Therefore, different tomato germplams from different origin were collected and studied with objective to evaluate the germplasms for agronomic performances, lycopene variability and some quality parameters so as to select the best performing genotypes that can be recommended as

Corresponding Author: Jiregna Tasisa Dufera, Mizan-Tepi University, P.O. Box 260, Mizan Teferi, Ethiopia

a potential variety for production, as well as hybridization in breeding programmes for further genetic improvement this crop.

MATERIAL AND METHODS

Testing Location and Season: The study was conducted under irrigation condition during main production season from September 2011 to May 2012 under Mizan agro-ecology at trial field of Mizan-Tepi University, which is located between 6°09'N latitude and 35°E longitude at an altitude of 1400m above sea level, in sub humid tropic Southwestern part of Ethiopia. The area receives annual rain fall of 2000mm and average mean annual minimum and maximum temperature are 20°C and 28°C respectively. The soil type of the area belongs to the loam texture class, with 35% sand, 49% silt, 16% clay and pH 5.2.

Experimental Materials: The study was conducted using 21 tomato genotypes of different origin. The seeds of the germplasms were obtained from Melkasa and Bako agricultural Research Centers where they were collected from different part of the world and maintained.

Experimental Design and Trial Management: The experiment was conducted using Randomized Complete Block Design (RCBD) with three replications and plot size of 2.10 m x 5.0 m each having five rows. Inter-row spacing of 1m and intra-row spacing of 0.3m was maintained during the layout. Fertilizer 200Kg/ha DAP was broadcasted at transplant and 100Kg/ha urea was side dressed at early flowering stage [5]. Weeding, hoeing and watering were performed as required.

Data Collection: In this study, 13 parameters were evaluated on sample plants in each plot and the results were expressed as mean values. All the data were represent per plant observation except for marketable fruit yield and unmarketable fruit yield which were computed from the plot observation.

Further, Total Soluble Solids (TSS) was determined following the procedures described by [6]. Handheld refractometer with a range of 0.0 to 32.0 °Brix and a resolution of 0.2 °Brix was used to determine the TSS. One to two drops of clear extracted juice was put on the prism. Between samples the prism of refractometer was washed with distilled water and dried before use. The referactometer was standardized against distilled water (0.0 % TSS).

The lycopene content of the fruits was measured following the procedures described by Ranganna, [7]. Three to four tomato fruits (sample) were taken and pulped using blender. Five milligram of the pulp was taken and extracted repeatedly using pestle and mortar. The acetone extracts was pooled and transferred to separating funnel containing 20ml petroleum ether and mixed gently. About 20ml of 5% sodium sulphate solution was added to the separating funnel and shaken gently. The two phases was separated and the lower aqueous phase was re-extracted using additional 20ml petroleum ether. The petroleum extract was pooled and washed with distilled water and poured into brown bottle containing 10mg anhydrous sodium sulphate and kept for 30min. And the petroleum extract was decanted in to a 100ml volumetric flask through a funnel containing cotton wool and sodium sulphate slurry was washed with petroleum ether and transferred to volumetric flask. The volume was made up and the absorbance was measured in spectrophotometer at 503nm using petroleum ether as blank.

Statistical Procedures

Analysis of Variance: The data collected for each trait were subjected to analysis of variance for Randomized Complete Block Design as per the procedure described by [8]. SAS statistical software package [9] was employed for analysis of variance of the traits. The statistical significance was determined by using F-test. List significance difference (LSD) was used to separate the mean performance of the genotypes which were significantly different [8].

Estimates of variability, phenotypic and genotypic coefficients of variation were estimated following the formula described by Johnson *et al*. [10].

RESULTS AND DISCUSSION

Result from analysis of variance showed highly significant difference among the genotypes ($P<0.0001$) for the characters evaluated (Table 1 and 2). Similar findings were reported by [11] and [12] for the tomato characters studied. This indicates the existence of sufficient genetic variability among evaluated genotypes and the scope for selection for further improvement of this crop.

Maximum average fruit yield per plant (1.61Kg) was recorded by genotype Roma VF followed by Cochoro (Pace setter) (1.54 Kg), Melkashola (Red pear) (1.52Kg), Pirson (1.38Kg), H-1350 (1.38Kg) (Table 1), showing these varieties are highly promising under these agro ecology. Varieties Fetan (Picador) (9.73 kg), Beefsteak (8.64 kg), Pishola (Floradado) (8.43 kg), CLN-2037H (8.12 kg) and Metadal (Caraibo) (8.06 kg) recorded relatively higher average marketable fruit yield per plot values (Table 1),

Table 1: Estimates of yield and yield components of tomato genotypes evaluated under Mizan agro ecology during 2011/2012

Genotypes	Days to maturity	Plant height (Centimeter)	Number of branches (Number)	Number of Fruits per plant	Unmarketable (Kilo gram per plot)	Marketable (Kilo gram per plot)	Yield per plant (Kilogramperplant)
BL1198=NCEBR-1	78.33^{jlk}	67.10^{gh}	7.07^{b}	21.00efg	4.11^{e}	11.90^{c}	1.21^{bcde}
Metadal(Caraibo)	86.67^{cb}	106.42^{c}	5.20^{efg}	15.73^{fghijk}	5.58^{bc}	8.06^{ef}	0.97^{efd}
Melkasalsa	78.33^{fg}	60.16^{jkh}	7.25^{b}	51.77^{b}	2.25^{i}	8.03^{ef}	0.76^{fghi}
Beefsteak	81.67^{e}	60.34^{jk}	3.89^{j}	13.00^{jkl}	6.66^{a}	8.64^{e}	1.02^{cdef}
CLN2037F	87.00b^{bc}	69.85^{g}	4.13^{hij}	21.76^{ef}	1.69^{ij}	7.49^{fg}	0.61^{ghijk}
CLN-2037H	85.00^{cd}	131.16^{a}	6.59^{bc}	49.50^{b}	4.10^{e}	8.12^{ef}	0.81^{fgh}
Cochoro(Pace setter)	71.33^{gh}	67.27^{gh}	9.30^{a}	29.27^{d}	5.10^{cd}	13.41^{b}	1.54^{ab}
Tomato 1365/95	77.67^{g}	84.30^{f}	6.44^{bcd}	15.00^{ghijk}	3.12^{gh}	3.12^{j}	0.39^{jkl}
CHali(Riogrande)	76.33^{g}	68.04^{gh}	5.05^{efgh}	8.10^{l}	1.10^{j}	1.54^{k}	0.22^{l}
Unknown 13	89.00^{b}	103.51^{c}	5.53^{def}	19.53^{fghi}	1.66^{ij}	5.17^{hi}	0.45^{hijkl}
Pishola(Floradado)	85.67^{c}	62.21^{ij}	4.05^{ij}	12.93^{kl}	2.11^{i}	8.43^{e}	0.70^{fghij}
Eshete (Calypso)	93.67^{a}	117.25^{b}	4.35^{ghij}	9.97^{kl}	1.87^{i}	2.39^{j}	0.28^{kl}
Melkashola(Red pear)	72.67^{h}	64.47^{hi}	5.29^{ef}	36.12^{c}	2.14^{i}	15.82^{a}	1.52^{ab}
Fetan (Picador)	81.00^{ef}	57.74^{k}	4.72^{fghij}	20.60^{efgh}	4.83^{d}	9.73^{d}	0.97^{efg}
H-1350	85.33^{c}	127.68^{a}	8.99^{a}	18.16^{fghij}	3.48^{fg}	12.93^{b}	1.33^{abcd}
CLN-2037E	89.00^{b}	88.52^{e}	4.65^{fghij}	26.09^{de}	5.94^{b}	5.92^{h}	0.80^{fgh}
CL-5915 D4-2-2-0	85.33^{c}	129.27^{a}	4.09^{ij}	14.41^{hijkl}	2.03^{i}	4.40^{i}	0.43^{ijkl}
Pirson	82.33^{de}	66.21^{gh}	7.11^{b}	20.40^{efgh}	3.94^{ef}	13.03^{b}	1.38^{abc}
CLN-2037 I	85.33^{c}	92.82^{d}	4.98^{efghi}	20.43^{efgh}	1.77^{j}	10.37^{d}	0.81^{fgh}
Roma VF	76.67^{g}	51.54^{l}	9.22^{a}	59.03^{a}	2.84^{h}	16.38^{a}	1.61^{a}
Marglobe	87.33^{bc}	89.20^{de}	4.56^{cde}	13.59^{ijkl}	4.02^{ef}	7.18g	0.75^{fghij}
Level of significance	***	***	***	***	***	***	***
Over all Mean± SE	82.65±1.43	84.05± 1.92	5.90±0.46	23.64± 3.20	3.35± 0.29	8.67± 0.41	0.88±0.18
CV (%)	2.12	2.80	9.62	16.57	10.72	5.77	24.65
LSD (5%)	2.89	3.89	0.94	6.47	0.59	0.83	0.36

Means with same letter (superscript) in the same column are not significantly different at 5 per cent level of significance
*** = Indicates significant differences at P≤0.00

Table 2: Estimates quality performance of tomato genotypes evaluated under Mizan agro-ecology during 2011/2012

Genotypes	TSS (°Brix)	Lycopene Content (mg per 100g)
BL1198=NCEBR-1	3.06^{efg}	3.10^{ab}
Metadal(Caraibo)	3.15^{efg}	1.02^{h}
Melkasalsa	2.23^{hi}	1.58^{f}
Beefsteak	1.68^{i}	1.09^{gh}
CLN2037F	3.85^{cd}	1.58^{f}
CLN-2037H	3.53^{cde}	1.76^{ef}
Cochoro(Pace setter)	3.83^{bcd}	1.67^{ef}
Tomato 1365/95	3.27^{defg}	3.29^{a}
CHali(Riogrande)	2.72^{gh}	2.09^{ab}
Unknown 13	3.34^{cdef}	3.10^{ab}
Pishola(Floradado)	3.50^{cde}	0.90^{h}
Eshete (Calypso)	2.82fg	1.65^{ef}
Melkashola(Red pear)	3.27^{defg}	1.09^{gh}
Fetan (Picador)	3.58^{cde}	2.86^{ab}
H-1350	2.72^{gh}	2.27^{cd}
CLN-2037E	3.03^{efg}	0.97^{h}
CL-5915 D4-2-2-0	3.02^{efg}	1.97^{def}
Pirson	4.30^{b}	1.51^{fg}
CLN-2037 I	3.41^{cde}	1.76^{ef}
Roma VF	4.92^{a}	2.94^{ab}
Marglobe	3.08^{efg}	2.62^{bc}
Level of significance	***	***
Over all Mean± SE	3.25± 0.29	1.94±0.24
CV (%)	10.73	15.09
LSD (5%)	0.58	0.48

Means with same letter (superscript) in the same column are not significantly different at 5 per cent level of significance
*** = Indicates significant differences at P≤0.001

showing their relatively better performance under this agro ecology than the rest of genotypes evaluated. Comparatively early maturing behavior was observed from the varieties Cochoro (Pace setter), Melkashola (Red pear), CHali (Riogrande), Roma VF and Tomato 1365/95 (Table 1). The varieties Eshet (Calypso), Unknown 13, CLN-2037E, Marglobe and CLN2037F (Table 1) showed late maturing behavior under the condition when compared to the other genotypes.

Higher total soluble solids (TSS) values were recorded by genotypes Roma VF (4.93), Pirson (4.30), CLN2037F (3.85), Cochoro (Pace setter) (3.83) and Fetan (Picador) (3.58) (Table 2), indicating these genotypes are performing under this condition if they are grown for processing purposes. The genotypes Tomato 1365/95, BL1198=NCEBR-1, Unknown 13, Roma VF and Fetan (Picador) reordered relatively higher lycopene value (Table 2), indication these varieties are promising for this important anti-oxidant chemical.

Higher values of genotypic coefficients variation (GCV) and phenotypic coefficients variation (PCV) were recorded for the characters of fruit clusters per plant (67.64, 69.07), nodes on main stem (58.05, 58.64), fruits per plant (54.33, 57.24), yield per plant (43.94, 50.74) and lycopene content (43.22, 46.22) (Table 3).

Table 3: Estimates of genotypic (GCV), phenotypic (PCV) and environmental (ECV) coefficients of variation for different characters of tomato germplasms evaluated under Mizan-agro-ecology during 2011/2012

Character	GCV(%)	PCV(%)	ECV(%)
Number of fruit clusters per plant	67.64	69.07	13.99
Number of fruit per cluster	24.13	26.93	11.97
Stem diameter	12.28	14.10	6.93
Days to maturity	8.25	8.50	2.03
Plant height	32.01	32.45	5.28
Number of nodes on main stem	58.05	58.64	8.26
Fruit diameter	17.76	19.02	6.81
Fruit length	17.92	19.62	7.99
Shape index	28.43	29.32	7.20
Number of fruits per plant	54.33	57.24	18.03
Total soluble solids	22.69	24.57	9.43
Lycopene content	43.22	46.21	16.37
Matketable	47.55	48.42	9.13
Unmarketable	39.23	41.29	12.90
Yield per plant	43.94	50.74	25.38

This indicates the presence of potential variability among the population studied for these characters further improvement. Lower differences between PCV and GCV were recorded for the characters days to maturity, plant height and nodes on the main stem, indicating lower environmental influences on the characters. The characters yield per plant, lycopene content and fruits per plant recorded higher differences between PCV and GCV, indicating higher influence of environment on the characters and their less feasibility for direct section for improvement.

SUMMARY AND CONCLUSION

Analysis of variance revealed that there was highly significant difference among the genotypes for all characters studied. The characters fruit clusters per plant, nodes on main stem, fruits per plant, yield per plant and lycopene content showed higher values of genotypic and phenotypic coefficients variations, indicating the presence of exploitable variability among the studied genotypes to improve these characters through selection.

The genotype Roma VF, Cochoro (Pace setter), Pirson and Fetan (Picador) showed over all better yield and quality (Total soluble solids and lycopene content) performances compared to the others, indicating their feasibility for commercial production under Mizan agro-ecological condition. Varieties Fetan (Picador), Beefsteak, Pishola (Floradado), CLN-2037H and Metadal (Caraibo) recorded relatively higher average marketable fruit yield per plot value, showing their relatively better agronomic performance under this agro ecology than the rest of genotypes evaluated. The varieties Cochoro (Pace setter), Melkashola (Red pear), CHali (Rio Grande), Roma VF and Tomato 1365/95 showed early maturing behavior under the condition when compared to the other genotypes, indicating these varies can be grown under this condition higher yielding purpose.

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