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Evaluation of Released Tomato (*Lycopersicon Esculentum* Mill.) Varieties for Fruit Yield and Quality Parameters in Western Ethiopia

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Abstract

The aim of the study was to evaluate the performance of 12 tomato varieties for marketable fruit yield and other agronomic and quality parameters; and to estimate the magnitude of associations among the agronomic and quality parameters of tomato varieties. The experiments were conducted at Wayu Tuka and Bako Tibe Districts of Western Ethiopia in 2018 under irrigation conditions. The experiment consisted of 12 tomato varieties, laid out in randomized complete block design (RCBD) with three replications. Data were collected for agronomic and quality parameters and ANOVA was carried out using GLM procedures of SAS (SAS, 2004, version 9.0). The difference between two means were tested for significance using Least Significant Difference method of Fisher's Statistics at P=0.05 probability level. The results indicated that significant differences were observed among the different tomato varieties for most of the vegetative characteristics and yield components. The combined analysis of variance revealed significant effect of location and Genotype x Location interaction on the expression of traits. The highest mean number of fruits per plant was recorded for Melkasalsa (77.54) while the lowest was for Metadel (25.49) variety. The highest marketable fruit yield was recorded for Melkasalsa variety (21.76 t ha^{-1}) whereas the smallest was recorded for Metadel variety (10.68 t ha^{-1}). The lowest pH value was recorded in varieties Galilema and Bishola with the value of 3.86 and 3.98 respectively. In terms of TSS, Cochora (5.27%) and Melkashola (5%) varieties were superior and followed by Chali (4.97%) variety at Wayu Tuka while Bishola (5.63%) and ARP tomato D2 (5.27%) were superior at Bako Tibe. Number of trusses per plant, number of fruits per plant as well as number of fruits per truss showed a positive significant association with marketable fruit yield at both field conditions. In conclusion the results indicated that the chemical quality parameters of most of the tested varieties are in standard ranges for tomato fruit quality. In terms of marketable yield, Melkasalsa variety can be recommended for the two study areas while in terms of fruit quality, Bishola for Bako Tibe and Cochora, Melkashola and Chali for Wayu Tuka location.

Keywords

Fruit Quality, Marketable Yield, pH, Tomato Varieties, Total Soluble Solid

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1. Introduction

Tomato (*Lycopersicon esculentum* Mill.) belongs to the family *Solanaceae*, which includes more than 3000 species. *Solanum* section *Lycopersicon* includes the cultivated tomato, *Solanum lycopersicum*, the only domesticated species, and a dozen other wild relatives [1]. There are approximately twelve species within genus *Lycopersicon*. On the basis of fruit colour, all these species have been classified into sub genera, viz., *Eulycopersicon* (characterized by red fruits with

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carotenoid pigmentation and annual growth habit) and *Eriopersicon* (characterized by green fruits with anthocyanin pigmentation). The cultivated species of Tomato (*L. esculentum*) and one wild species (*L. pimpinellifolium*) belong to *Eulycopersicon* and these two species were classified into five botanical varieties. There are 16 wild species of tomato, including *S. habrochaites, S. pennellii, S. pimpinellifolium, S. cheesmaniae, S. galapagense, S. peruvianum, S. corneliomulleri, S. chilense, S. chmielewskii, S. arcanum, S. neorickii, S. huaylasense, S. lycopersicoides, S. ochranthum, S. jugandifolium, and S. sitiens* [2]. One of these varieties, namely, *L. esculentum* var. *ceraseform* (cherry tomato) is considered as the immediate ancestor of present day cultivated tomato.

Tomato is herbaceous edible fruiting plant. It is a self-pollinated diploid species with twelve pairs of chromosomes (2n =2x = 24) [3]. It is one of the most important edible and nutritious vegetable crops, widely cultivated in tropical, sub-tropical and temperate climates in the world. Universally, it is the second most consumed vegetable after potato [4, 5, 6]. It is a very versatile vegetable for culinary purposes. Tomatoes are consumed fresh, cooked or processed into various products. The tomato is composed mainly of water (approximately 90%), soluble and insoluble solids (5-7%), citric and other organic acids, and vitamins and minerals. Ripe tomatoes have a high content of the antioxidant lycopene, which plays a possible role in the prevention of certain forms of cancer [7]. Another important antioxidant carotene is also noted for its cancer prevention properties. Development of tomato cultivars that combine high yielding potential with improved nutritional and quality traits could be essential in the quest to meet the needs of tomato growers, fresh tomato consumers as well as the processing industry [7].

Tomatoes in Ethiopia are produced mainly in northern and central rift valley areas. According to [5] commercial tomato production in Ethiopia has significantly expanded as the national agriculture strategies gave the highest priority for the production of high value cash crops like tomato. In the year of 2018/2019 of Meher season the total production of tomato in Ethiopia was about 23,583.75 ton harvested from 4,322 hectare of land, with the productivity of about 5.46 t ha^{-1} [8]. Several production constraints identified for the low level of productivity. Inappropriate agronomic practices and high incidence of diseases and insect pests are among other the major constrains of tomato production in Ethiopia [9].

In Ethiopia, tomato is produced in the state and private horticultural enterprises, commercial farms and small farmers scattered in different parts of Ethiopia. It is produced mainly as a source of food and income both under rain fed as well as irrigated conditions. Tomato is among the most important vegetable crops in Ethiopia. In this context, developing superior yielding varieties through appropriate breeding work is mandatory to satisfy ever increasing demand of domestic and export markets for this crop.

Evaluation of germplasm is of immense important in genetic improvement of the crop. The production and productivity not only depends on cultural practices and area of cultivation but on high yielding genotypes, which have good adaptability to the growing area. Hence, evaluation of tomato genotypes is very essential to see the performance of genotypes for their adaptability and agronomic performance like growth and yield traits to identify the potential genotype.

Ethiopia's wide range of agro-climatic conditions and soil types make it suitable for the production of diverse varieties of vegetables and fruits both under rain fed and irrigation condition [10]. Large scale production of tomato takes place in the upper Awash valley, under irrigated and rain-fed conditions whereas small scale production for fresh market is a common practice around Koka, Ziway, Wondo-Genet, Guder, Bako and many other areas [9]. Although several genetic studies have been made in various vegetables, including tomato, in various parts of the world, due to the importance of genotype by environment interaction it's necessary to evaluate the genotypes at Bako and Wayu Tuka districts of western Ethiopia. Therefore, the present study was carried out with the objective of evaluating the performance of tomato varieties for their yield; yield components and quality related traits at Bako Tibe and Wayu Tuka districts of western Ethiopia.

2. Materials and Methods

2.1. Description of the Study Area

The experiments was conducted simultaneously in East Wollega Zone, Wayu Tuka district at Warrebabo Migna Kebele farmer's field and in West Shewa Zone, Bako Tibe district at Dembi Gobbu kebele farmer's field under irrigation condition in 2018/2019 off season.

The first site is located at 298km away from the capital city (Addis Ababa) to the west on the way to Nekemte in Warrebabo migna peasant association at $9^{0}2^{'}$N and $36^{0}4'$E at altitude 1910 m.a.s.l. The area is categorized as sub-tropical agro ecology receiving mono-modal type of rainfall from June to August. Production system of the area is mixed agriculture where the farmers produce field crops such as maize, wheat, barley and livestalk such as cattle, goat, sheep and chicken all in traditional method (Wayu Tuka District Data, unpublished).

The second experimental site is located at Bako Tibe district, Dembi Gobbu kebele farmer's field. Bako is located at 432km from Addis Ababa to the West and situated at an altitude of 1650 m. a. s. l, 9°06' north latitude and 37°09' east longitude. Average annual rainfall at this location is 1246 mm. The rainy season lasts from April to October, with maximum rainfall in July and August. The soil type of the area is deep-weathered, well-drained, slightly acidic in reaction, clay to sandy clay loam at the surface, low in available P, total N, organic matter and available water holding capacity [11].

2.2. Experimental Materials

Seeds of eleven released tomato varieties and one locally cultivated variety (used as check) were used in the experiment. Those released varieties were obtained from Melkassa Agricultural Research Center (MARC) while the locally cultivated variety (Roma VF) was obtained from local market as listed below (Table 1).

Table 1. Some descriptions of tomato varieties used for the study.

S/No	Variety name	Year of release	Environmental requirements		Growth habit	Days to maturity	Utilization
			Altitude (m)	Rainfall (mm)			
1	Cochoro	2007	800-2000	1400	DT	100-120	-
2	Miya	2007	500-2000	1200	IDT	82	-
3	Fetan	2005	700-2000	1200	DT	78-80	Fresh
4	ARP tomato d2	2012	700-2000	1400	DT	100-120	Fresh
5	Bishola	2005	700-2000	1200	DT	85-90	Fresh
6	Melkashola	1998	700-2000	1400	DT	100-120	Processing
7	Chali	2007	700-2000	1400	DT	110-120	Processing
8	Melkasalsa	1998	700-2000	1400	DT	100-110	Processing
9	Metadel	2005	700-2000	1400	SDT	78-80	Fresh
10	Eshet	2005	700-2000	1400	DT	75-80	-
11	Gelilema	-	-	-	-	-	-
12	Roma VF	1978	700-2000		DT	-	Fresh

DT= determinate; IDT= indeterminate; SDT= semi determinate (Source: [12, 13]).

2.3. Raising Seedlings

Seeds were sown in November 2018, on well prepared raised nursery beds of having a seed bed size of 1.2 m^2 (1 m length, 8 rows, 0.15 m spacing between rows). About 50 cm distances kept between two beds to carry out operations of watering, weeding, etc. Sown seeds were covered lightly with fine soil and then with two to three cm thick grass mulch. Daily watering of seedlings (early morning and late afternoon) was carried out following germination using watering can. Other pertinent agronomic and horticultural practices applicable to tomato were also followed on the nursery. Thinning was carried out at 2-3 leaves stage in order to maintain optimum plant population and to keep seedlings vigorous.

2.4. Experimental Procedures, Seedlings Transplanting and Experimental Design

The experimental field was well prepared ahead of seedling transplanting using human labor. The seed beds were watered before uprooting the seedlings in order to minimize the damage of the seedlings root. Transplanting of seedlings on experimental field was done at 3-5 true leaves stage when seedlings attain the height of about 15-25cm. Healthy, uniform and vigorous seedlings were transplanted into well prepared field early in the morning and late afternoon at spacing of 100 cm and 30 cm between rows and plants respectively [14]. Each plot has a size of 6m^2 and the total experimental area was 405m^2. The treatments were arranged in RCBD with three replications. Plots and blocks were separated by 0.5m and 1m respectively. Watering was done using furrow irrigation at three days interval. The whole amount of DAP (100$kgha^{-1}$) recommended to the area was applied during transplanting while the recommended rate of urea (250$kgha^{-1}$) was applied in to two equal splits. The first half of urea was applied at the time of transplanting while the remaining half applied 21 days after transplanting of seedlings. Experimental plots were kept free from weeds manually and other cultural practices such as disease and insect pest control were performed as per the recommendation for tomato production.

2.5. Data Collection

Data were collected for the following phenological, yield components and quality parameters: Days to 50% flowering, Days to 50% maturity, Plant height (cm); Number of primary branches per plant, Number of fruits per plant; Number of locules per fruit, Number of truss per plant, Single fruit weight (g), Number of fruit per truss, Marketable fruit Yield (t/ha), unmarketable fruit yield (t/ha), total fruit yield (t/ha), mean fruit dry matter content (total solids), Total soluble solids (TSS) of fruit juice *(^{o}Brix),* and pH (Figure 1).

Figure 1. Fruit quality analysis procedures in the laboratory.

2.6. Statistical Analysis

Data collected from the two locations were subjected to analysis of variance (ANOVA) using GLM procedures of SAS software [15]. Combined analysis of variance was performed following the procedure (16). Mean comparison for the significance was carried out with Fisher's Least Significant Difference (LSD) test at 5% probability level.

The General linear additive model used was;

$$Y_{ijk} = \mu + G_i + L_j + (G \times L)_{ij} + Rj_{(k)} + E_{ijk}$$

where, Y_{ijk} is the observation on the i^{th} genotype in the j^{th} location in the k^{th} replication, μ is the general mean, Gi is the fixed effect of the j^{th} genotype, Lj is the effect of the j^{th} location, $(G \times L)_{ij}$ is the interaction of the i^{th} genotype with j^{th} location, $Rk_{(j)}$ is the effect of k^{th} randomized block within the j^{th} location and E_{ijk} is the experimental error associated within the ijk^{th} observation.

3. Results and Discussion

3.1. Analysis of Variance

The results of analysis of variance for yield components and quality traits at each location showed a highly significant variation among tomato varieties for marketable yield and most other traits. This was an indication that the responses of the varieties were different in each location for marketable yield and those traits, which were under consideration.

3.2. Phenological Parameters of Tomato Varieties

3.2.1. Days to 50% flowering

The analysis of variance showed that the days to 50% flowering were highly significantly (p<0.01) different among tested tomato varieties at Wayu Tuka and Bako Tibe experimental sites (Table 2). At Wayu Tuka location the earliest days to 50% flowering was recorded from variety Roma VF (49.67days) which is statistically in par with varieties Cochora (51.48 days) and Metadel (54.83 days). While, the longest days to 50% flowering was recorded from variety Galilema (67.08days) which is statistically in par with the varieties Chali (64.00 days) and ARP tomato D2 (64.01 days). At Bako Tibe, the earliest days to reach 50% flowering was observed from variety Roma VF (47.66days) which is statistically in par with Fetan (48.49 days), where as the longest days was recorded from Melkasalsa variety (63.67). The combined analysis of variance revealed that days to 50% flowering was highly significantly different among the tomato varieties, indicating that the order or rank of varieties is changed due to the effect of environmental factors and soil conditions. This needs testing of varieties in each location for specific trait performance or the performance of the varieties with the trait is not predictable by testing only one location. Early flower formation was observed from the ROMA VF variety (48.67 days) while the maximum days to 50% flowering were observed from the Galilema variety (63.94 days) (Table 3). Earliness or lateness in the days to 50% flowering might have been due to their inherited characters, early acclimatization to the growing area to enhance their growth and developments.

According to [17, 18) days to 50% flowering ranged between 40 and 49 for tested tomato varieties. The differences in days to 50% flowering among the varieties are due to the differences in genetic background and day length or radiation hours. Moreover [19, 20], stated that both genotypic and environmental factors influence tomato plants to flower early or delay in flowering. Generally, the performances of the genotypes for reproductive and phenological traits were inconsistent across the experimental locations due to the interaction between genotype and the environment.

3.2.2. Days to 50% Fruit Maturity

The days to 50% fruit maturity was highly significantly (*P<0.01*) influenced by tomato varieties for each location and for combined analysis (Table 2). The significant interaction of variety by location for fruit maturity indicates that the rank of varieties for the traits would change as the location varies. The shortest number of days to 50% fruit maturity was recorded from Cochora variety (96.11 days) which is not significantly different from Metadel (96.29 days) and ROMA VF (98.62 days) varieties. While maximum days required to attain 50% fruit maturity was recorded from Chali (116.81days), which is statistically in par with ARP tomato D2 (115.28 days), Eshet (115.17 days), Melkashola (114.57 days) and Galilema (114.28 days) varieties at WayuTuka experimental field. Whereas at Bako Tibe location the shortest duration was recorded from ROMA VF variety (94.72days) which is statistically similar with Fetan (95.05days) and Bishola (95.77days) varieties while the maximum days required to attain 50% fruit maturity was recorded from Melkasalsa variety (116.16 days).

The mean for combined analysis showed that early fruit maturity was observed for ROMA VF variety (96.67days), which is statistically in par with Fetan (97.94 days) and Bishola (98.39 days) varieties. The maximum days to attain fruit maturity from combined analysis were observed for Chali variety (114.34 days) but not significantly different from Melkasalsa (113.99days), Eshet (113.47 days), Melkashola (113.33days), and Galilema (112.63days) varieties (Table 3). The variations in days to fruit maturity could be due to the differences in the growing environment, climatic conditions and or due to the genetic make-up of the varieties. In the present study, the tested tomato varieties took 94.72 to 116.16 days to produce mature fruits. Other researchers reported that tomato varieties give the first harvest in 70-120 days after transplanting [17]. Early maturing varieties are important for early marketing in the season, which mostly fetch good price. [21] reported that wide differences (103-127 days) in maturity for 25 tomato genotypes studied in Iran. Different researchers [22, 23] reported wide range of differences in maturity (73-93 days and 69-156 days) for 21 tomato genotypes evaluated in Mizan Tepi, Ethiopia and for 36 tomato genotypes evaluated in Humera, Ethiopia respectively. [17], stated that the early or late maturity is attributed by genotypic character and in the extent influenced by the environmental factors of any particular growing area.

Table 2. Mean square values for 14 characters of tomato varieties evaluated in Guto Wayu and Bako Tibe districts of western Ethiopia in 2018 off season.

Characters	Rep. (DF=2)	Var. (DF=11)	Loc. (DF=1)	Var * Loc (DF=11)	Error (DF=46)
Days to 50% flowering	0.87^{ns}	141.18**	112.33**	48.7**	2.63
Days to 50% fruit maturity	0.02^{ns}	362.15**	78.42**	31.53**	2.25
Plant height (cm)	33.6ns	1365.81**	26480.68**	621.81**	49.89
# of primary branches per plant	0.25^{ns}	1.2*	227.63**	1.85**	0.57
# of trusses per plant	122.96*	354.79**	5078.64**	130.62**	16.9
# of fruits per truss	0.3^{ns}	2.61**	12.9**	0.38*	0.16
# of frits per plant	756.58*	2184.66**	34875.3**	722.95**	76.4
# of locules per plant	0.79^{ns}	3.7**	1.68 ^{ns}	0.38 ^{ns}	0.52
Single fruit weight (g)	51.09^{ns}	3918.3**	434.2*	134.7*	64.77
Marketable fruit yield (t/ha)	0.15*	83.3**	805.7**	9.27**	0.26
Unmarketable fruit yield (t/ha)	0.01^{ns}	0.09^{ns}	0.05^{ns}	0.03^{ns}	0.03
Total fruit yield (t/ha)	0.11^{ns}	88.5**	803.14*	9.78**	0.25
Total soluble solid	0.09^{ns}	2.23**	1.59**	0.14**	0.05
Acidity content (pH)	0.01^{ns}	0.23**	0.06**	0.02**	0.01
Fruit dry matter content	0.085*	1.66**	0.05^{ns}	0.54**	0.05

* =Significant at (p<0.05), ** = highly significant at (p<0.01) and ns = non-significant (p≥0.05), Df = Degree of freedom.

Table 3. Mean days to 50% flowering and days to 50% fruit maturity of tomato varieties at Wayu Tuka and Bako Tibe farmers' fields during 2018/2019 under irrigation.

Tomato Varieties	Days to 50% flowering			Days to 50% maturity		
	Wayu Tuka	Bako Tibe	Mean	Wayu Tuka	Bako Tibe	Mean
ROMA VF	49.67^{d}	47.66^{e}	48.67^{e}	98.62d^{e}	94.72^{f}	96.67^{e}
Bishola	56.17^{c}	50.41^{d}	53.29^{cd}	101.00^{cd}	95.77^{ef}	98.39^{de}
Miya	56.40^{c}	50.08^{d}	53.24^{cd}	102.83^{c}	97.50^{e}	100.16^{c}
Eshet	63.82^{b}	58.80^{bc}	61.31^{b}	115.17^{a}	111.78^{b}	113.47^{ab}
Galilema	67.08^{a}	60.79^{b}	63.94^{a}	114.28^{ab}	111.00^{bc}	112.63^{ab}
Melkashola	63.04^{b}	56.78^{c}	59.91^{b}	114.57^{ab}	112.08^{b}	113.33^{ab}
Chali	64.00^{ab}	57.79^{c}	60.90^{b}	116.81^{a}	111.87^{b}	114.34^{a}
ARP tomato d2	64.01^{ab}	58.05^{c}	61.03^{b}	115.28^{a}	108.80^{c}	112.04^{b}
Fetan	54.83^{c}	48.49^{de}	51.66^{d}	100.83^{cd}	95.05^{f}	97.94^{de}
Cochora	51.48^{d}	57.61^{c}	54.55^{c}	96.11^{e}	101.50^{d}	98.81^{cd}
Melkasalsa	56.74^{c}	63.67^{a}	60.21^{b}	111.83^{b}	116.16^{a}	113.99^{a}
Metadel	50.22^{d}	57.36^{c}	53.79^{c}	96.29^{e}	102.33^{d}	99.31^{cd}
LSD (5%)	3.25	2.26	1.89	2.88	2.26	1.74
Mean	58.12	55.62	56.87	106.96	104.88	105.92
CV (%)	3.29	2.40	2.85	1.59	1.27	1.41

Means within a column sharing common letter(s) are not significantly different at P=0.05, LSD= Least significance difference CV=coefficient of variation

3.3. Growth Parameters of Tomato Varieties

3.3.1. Plant Height (cm)

Analysis of variance revealed that plant height showed highly significant (P<0.01) difference among the tomato varieties at both locations (Tables 2). The tallest plant height was recorded from Eshet variety (72.44cm) which was not statistically different from Bishola variety (69.28 cm) while the shortest plant height were recorded from ARP tomato D2 variety (51.49 cm), but not significantly different from Miya (53.66 cm), Chali (54.66cm) Melkasalsa (55.49cm) and Cochora (56.98cm) tomato varieties at Wayu Tuka experimental site. Similarly, at Bako Tibe the tallest plant height was recorded from Eshet variety (171.58cm), whereas the shortest plant height was recorded from Chali variety (71.69 cm). This result was in agreement with the findings of [24] who stated that Eshet was characterized as taller variety. From the combined analysis the highest plant height was recorded from Eshet variety (122.01cm) and the shortest plant height was recorded from Chali variety (63.18cm) (Table 4). The mean plant height of the tested tomato varieties was ranged from 51.49cm to 122.01cm. [18*]* also reported that the height of tomato plants ranged from 36.80-126.7 cm. [25] reported wide range of differences (61.6-126.5cm) in plant height among the 10 tomato genotypes evaluated in Pakistan. Similarly, [23] obtained wide difference (51.5-129.7 cm) for plant height in tomato in Ethiopia.

3.3.2. Number of Primary Branches Per Plant

Mean number of primary branches per plant was highly significantly *(P<0.01)* different among 12 tomato varieties at Wayu Tuka and for combined analysis while it was significantly (P<0.05) different at Bako Tibe (Tables 1). The maximum number of primary branches per plant were recorded from variety Cochora (5.50), but it is not significantly different from Galilema (5.33), ARP tomato D2 (5.24), Eshet (5.00) Metadel (5.00) and Fetan varieties (4.50). Whereas the minimum number of primary branches per plant were recorded from Bishola variety (3.00), though it is statistically in par with Chali (3.58), ROMA VF (3.83), Miya (3.83) and Melkasalsa varieties (3.94) at Wayu Tuka experimental field. The mean for both locations indicated that highest number of primary branches per plant was recorded from Metadel variety (6.88) and the smallest number of primary branches per plant was recorded from Fetan variety (5.50) (Table 4). [17] reported that the primary branches per plant of tomato ranged from 3.1 to 12.6 per plant. [26] reported that number of branches per plant varied for different cultivars due their genetic makeup or differences. Generally, the differences observed in number of primary branches per plant might have been due to genetic variations existed between varieties and/ or due to the genotype environment interactions across locations.

Table 4. Mean of plant height and number of primary branches per plant of tomato varieties at Wayu Tuka and Bako Tibe farmers fields during 2018/2019 under irrigation.

Tomato varieties	Plant height (cm)			Number of primary branches per plant		
	Wayu Tuka	Bako Tibe	Mean	Wayu Tuka	Bako Tibe	Mean
ROMA VF	60.98[b]	96.64[bcd]	78.81[cd]	3.83[cd]	8.11[Ns]	5.97[bcde]
Bishola	69.28[a]	107.25[b]	88.26[b]	3.00[d]	8.25 [Ns]	5.63[de]
Miya	53.66[bc]	95.08[bcd]	74.37[cdef]	3.83[cd]	8.50 [Ns]	6.17[abcde]
Eshet	72.44[a]	171.58[a]	122.01[a]	5.00[ab]	8.00 [Ns]	6.50[abcd]
Galilema	59.22[b]	88.08[d]	73.65[cdef]	5.33[ab]	7.83 [Ns]	6.58[abc]
Melkashola	59.94[b]	103.11[bc]	81.53[bc]	4.43[bc]	8.50 [Ns]	6.46[abcd]
Chali	54.66[bc]	71.69[e]	63.18[g]	3.58[cd]	8.44 [Ns]	6.01[abcde]
ARP tomato d2	51.49[c]	84.25[de]	67.87[fg]	5.24[ab]	7.97 [Ns]	6.61[ab]
Fetan	59.44[b]	89.67[cd]	74.55[cdef]	4.50[abc]	6.50 [Ns]	5.50[e]
Cochora	56.98[bc]	83.58[de]	70.29[efg]	5.50[a]	7.50 [Ns]	6.50[abcd]
Melkasalsa	55.49[bc]	90.00[cd]	72.74[def]	3.94[cd]	7.50 [Ns]	5.72[cde]
Metadel	60.57[b]	93.50[bcd]	77.04[cde]	5.00[ab]	8.77 [Ns]	6.88[a]
LSD (5%)	7.62	14.86	8.20	1.01	1.51	0.88
Mean	59.51	97.87	78.69	4.43	7.98	6.21
CV (%)	7.56	8.96	8.97	13.47	11.19	12.20

Means within a column sharing common letter(s) are not significantly different at P=0.05, Ns= Non- significance difference; LSD= Least significance difference CV=coefficient of variation

3.4. Yield and Yield Components of Tomato Varieties

3.4.1. Number of Trusses Per Plant

The analysis of variance for number of truss per plant showed highly significant ($p<0.01$) differences among tested tomato varieties (Table 2). The highest number of trusses per plant was recorded from ROMA VF variety (16.28) which is statistically similar with Melkasalsa (15.22), Melkashola (14.22) and Miya varieties (13.33). The smallest number of truss per plant was recorded from Metadel variety (6.89) but not significantly different from Bishola (7.00), Eshet (8.17), Galilema (9.89), ARP tomato D_2 (9.56), Chali (7.58) and Fetan (10.06) varieties at Wayu Tuka experimental field (Figure 2). However, at BakoTibe location the highest number of truss per plant was obtained from Melkasalsa (47.83) variety and the smallest number of truss per plant was recorded from Eshet variety (12.67). Similarly, from the combined analysis highest number of truss per plant was obtained from Melkasalsa variety (31.53) and the smallest number of truss per plant was recorded from Eshet variety (10.42) but not significantly different from bishola (11.63), Chali (14.56), D2 (14.49), Cochora (15.02) and Metadel (11.78) on interaction location (Figure 2).

3.4.2. Number of Fruits Per Truss (cluster)

The mean of number of fruit per truss was highly significantly ($p<0.001$) different for the varieties at Wayu Tuka, Bako Tibe, and combined locations (Table 2). At Wayu Tuka, the highest number of fruit per truss was recorded from Melkasalsa (3.80) which is not significantly different from Miya (3.40) whereas the minimum is recorded from Chali (1.70). At Bako Tibe experimental site, the highest number of fruit per truss was recorded from ROMA VF (4.00), and it is statistically in par with Melkashola (3.97) and Melkasalsa varieties (3.93). While the smallest number of fruit per truss was recorded from Chali (1.95) at both experimental sites. Similarly, Averaged for the two locations, the maximum number of fruit per truss was recorded from Melkasalsa (3.87) which is no significantly different from Miya (3.63) and ROMA VF (3.42) varieties and the minimum was observed from Chali (1.83) (Figure 2).

According to [18], the number of flowers per cluster affects the number of fruits per clusters. It is one of the major criteria to select variety for its higher yielding potential. In general, the higher the number of fruits per cluster the more fruit yield is expected, although fruit size also determines the yield estimation [27]. The author indicated that fruit yield was strongly influenced by the number of clusters as well as by the number of fruits set per cluster.

3.4.3. Number of Fruits Per Plant

The mean number of fruits per plant was highly significantly *($P<0.01$)* different among 12 tomato varieties at both locations (Table 2). The highest number of fruits per plant was recorded from Malkasalsa variety (39.33) which is statistically in par with ROMA VF (36.34) and the smallest number fruits per plant was observed from Metadel (12.28) at Wayu Tuka location. Whereas the highest number of fruit per plant was recorded from Melkasalsa variety (115.75) which is statistically in par with ROMA VF (104.78), Miya (101.17) and melkashola (97.58); and the smallest number fruit per plant was observed from Eshet (36.78) and it is statistically in par with Metadel (38.69), Bishola (40.67), D2 (45.00), Cochora (48.92), Chali (49.39), Fetan (49.44) at Bako Tibe location (Figure 2). Similarly, over combined locations the maximum number of fruits per plant was recorded from Melkasalsa variety (77.54) and the minimum number of fruit per plant was recorded from Metadel (25.49).

The variations in fruits yield might be due to the influence of the growing environment such as temperature, and moisture and soil factors and the genetic potential of the varieties. Because, as a number of primary, secondary and tertiary branches increased, there could be a possibility of increasing the number of fruits producing buds, which are the locations for fruit production. Some authors reported that the mean number of fruits per plant ranged from 4.46 to 98.3 [28, 29]; and [30] reported a value between 9.70 and 158.9, while in Ethiopia, [9] reported that the fruits number per plant between 26 and 62.

Moreover, the variations in fruit development among varieties at both locations could also be due to the temperature stress of the growing environment and the capability of each varieties to with stand the stress specially on the reproductive development, which is more sensitive to high temperature stress (day and night temperatures variances) than vegetative development. Similarly, many researchers [19, 21, 22], reported wide range of differences (4.00 - 97.00) in number of fruits per plant in tomato genotypes.

3.4.4. Number of Locules Per Fruit

The analysis of variance showed that the number locules per fruit was highly significantly different ($P < 0.01$) among tested tomato varieties at Wayu Tuka and Bako Tibe experimental sites but the location effect and their interactions are not significant (Table 2). The smallest number of locules per fruit was observed from cochora (1.67) and (1.33) at Wayu Tuka and Bako Tibe experimental sites respectively. Accordingly, the highest number of locules per fruit was recorded from Eshet variety (4.00) and (5.00) but not significantly different from Bishola, Fetan and Metadel varieties at both Wayu Tuka and Bako Tibe respectively (Figure 2). The non-significant effect of locations and the genotype by location interaction might indicate the trait is least influenced by the environment but needs further investigation.

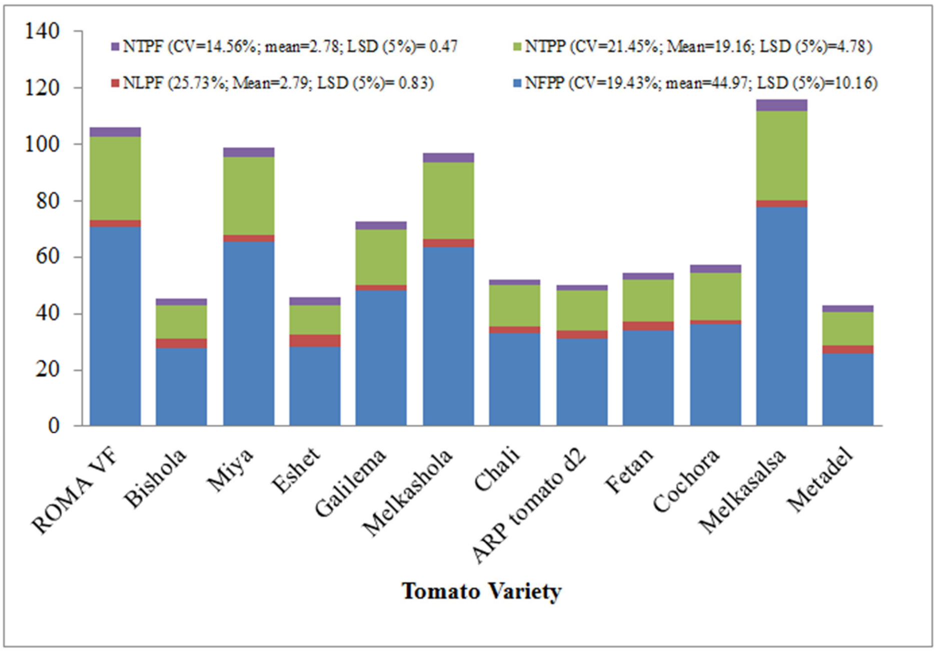

Figure 2. Mean values for number of trusses per fruit (NTPF), number of trusses per plant (NTPP), number of locules per fruit (NLPF) and number of fruits per plant (NFPP) of tomato varieties grown at Wayu Tuka and Bako Tibe Districts of Western Ethiopia.

3.4.5. Single Fruit Weight (g)

The results indicated that there was highly significant difference ($P < 0.01$) among the varieties for single fruit weight at both locations; and the effect of location and location x genotype interaction were significant for single fruit weight indicating that the performance of varieties could change with location (Table 2). Accordingly, the highest single fruit weight was recorded from variety Eshet (117.04) and (125.54) which is statistically in par with Metadel (113.25) and (122.03) at Wayu Tuka and Bako Tibe experimental sites respectively (Table 5). The lowest single fruit weight was recorded from Miya variety (46.33) but not significantly different from Cochora (46.5), Melkasalsa (51.61), Melkashola (52.22) and ROMA VF (59.4) varieties at Wayu Tuka location. Whereas the smallest single fruit weight at Bako Tibe location is recorded from Melkasalsa (43.41) and Miya (50.46) varieties. Similarly, for combined analysis, highest single fruit weight was recorded from variety Eshet (121.29) and the smallest single fruit weight was recorded from Melkasalsa variety (47.51) (Table 5). Though the results indicated that the genetic makeup of varieties are important; there is also influence on the trait due to the environment in which the varieties are growing (and/or the agro ecological factors including, soil type and its nutrient contents, temperature, availability of irrigation in the growing area based on the study period). Because, higher fruit weight can be considered as those receiving higher percentage of assimilate, which also indicate that a good combination of number of fruit and weight could improve quality through increase of fruit weight and fruit size.

The fruit sizes of the tested varieties are within the standard ranges for tomato fruits as reported by [9]. According to the report, the average weight of tomato fruits is in the range of 20 -180 g; and tomato fruits are categorized into small, medium and large based on the fruit weights with the value of <50g, 70-110g, 110-170g and >180g, respectively. Medium and large fruit categories are preferred generally for fresh market. Similarly, [25] reported a wide difference (48.7-88.3 g) in fruit weight for 11 tomato genotypes. The fruit weight per plant in this study agrees with previous reports by [13], who reported fruit weight per plant ranging between 1.1 and 1.7 kg.

3.4.6. Marketable Fruit Yield

The marketable fruit yield (t ha^{-1}) was highly significantly ($P<0.01$) different among 12 tomato varieties in both locations. The effect of location and location x genotype interaction were highly significant indicating the traits are highly influenced by the growing environment and there is a need to test varieties in each environment for adaptability (Table 2.). The results showed that the highest marketable fruit yield (18.8 t ha^{-1}) and (24.71 t ha^{-1}) was obtained from Melkasalsa variety at Wayu Tuka and Bako Tibe experimental site respectively. While the smallest marketable fruit yield was recorded from Metadel variety (6.01 t ha^{-1}) at Wayu Tuka and Eshet (14.66 t ha^{-1}) at Bako Tibe. Similarly, over the combined experimental sites the highest marketable fruit yield was recorded from Melkasalsa variety (21.76 t ha^{-1}) whereas the smallest marketable fruit yield was recorded from Metadel variety (10.68 t ha^{-1}) (Table 5).

The recorded variations of varieties in marketable yield could be due to their differences in genetic make-up and/or agro ecological adaptations compared to the locations in which they had evaluated. Marketable fruit yield is the major determinant variable for selection of a particular tomato variety, as it directly affects commercialization and thus income generation of the farms [27]. The marketable yields of the above mentioned tomato varieties were relatively good compared to the findings of [18] who reported the marketable fruit yield ranging from 7.21-43.80 t ha^{-1} in their studies. However, [31] reported the marketable yield of tomatoes in the range of 37.1 t ha^{-1} to 76.2 t ha^{-1}. Similarly, [22] reported highest fruit yield (56.07 t ha^{-1}) evaluating 36 tomato genotypes.

Table 5. Mean values of single fruit weight and marketable fruit yield of tomato varieties at Wayu Tuka and Bako Tibe farmers' fields, during 2018/2019 under irrigation.

Tomato varieties	Single fruit weight (g)			Marketable fruit yield (t ha^{-1})		
	Wayu Tuka	Bako Tibe	Mean	Wayu Tuka	Bako Tibe	Mean
ROMA VF	59.4^{d}	70.63^{de}	65.02^{e}	16.66^{b}	22.8^{b}	19.73^{b}
Bishola	89.67^{bc}	107.24^{b}	98.45^{b}	7.32^{g}	15.88^{fg}	11.60^{h}
Miya	46.33^{d}	50.46^{fg}	48.40^{f}	16.39^{b}	21.62^{c}	19.01^{c}
Eshet	117.04^{a}	125.54^{a}	121.29^{a}	10.88^{e}	14.66^{h}	12.77^{ef}
Galilema	82.64^{bc}	90.85^{c}	86.75^{c}	13.60^{d}	19.67^{d}	16.64^{d}
Melkashola	52.22^{d}	61.26^{ef}	56.74^{ef}	16.11^{bc}	21.25^{c}	18.68^{c}
Chali	81.96^{bc}	70.85^{de}	76.40^{d}	7.41^{g}	17.81^{e}	12.61^{fg}
ARP tomato d2	94.71^{b}	84.25^{cd}	89.48^{cb}	7.61^{g}	16.54^{f}	12.07^{gh}
Fetan	77.23^{c}	87.19^{c}	82.22^{cd}	8.89^{f}	17.56^{e}	13.23^{e}
Cochora	46.5^{d}	57.79^{ef}	52.14^{f}	15.36^{c}	17.51^{e}	16.44^{d}
Melkasalsa	51.61^{d}	43.41^{g}	47.51^{f}	18.8^{a}	24.71^{a}	21.76^{a}
Metadel	113.25^{a}	122.03^{a}	117.64^{a}	6.01^{h}	15.34^{gh}	10.68^{i}
LSD (5%)	13.5	13.76	9.35	0.95	0.79	0.59
Mean	76.04	80.95	78.50	12.08	18.77	15.43
CV (%)	10.5	10.04	10.25	4.68	2.5	3.31

Means within a column sharing common letter(s) are not significantly difference, LSD= Least significance difference CV=coefficient of variation

3.4.7. Unmarketable Fruit Yield

The analysis of variance showed that unmarketable fruit yield was non-significantly (*P>0.05*) different among 12 tested tomato varieties at both experimental sites as well as for combined analysis (Tables 2 and 6). This unmarketable yield was recorded through subjective judgment based on shrunken shaped fruits, small sized and discolored fruits that were estimated to be due to the differences in nutrients uses. In addition, those lacked uniformity when drying, and or due to physiological disorders (bleaching) during the fruit set or due to the climatic conditions of the growing environment during harvesting were considered as unmarketable pod yield.

According to [9], sun burnt, small sized cracked disease and insect pest damaged fruits are considered as unmarketable. Diseases and insect pests are the major constraints of tomato production in country, which result an increase in unmarketable yield. The observed varietal differences of unmarketable yields in the present study might be due to the difference in fruit pericarp thicknes.

3.4.8. Total Fruit Yield

Analysis of variance revealed that total fruit yield showed highly significant (P<0.01) difference among the 12 tomato varieties in both study areas. In addition, location effect and location x genotype effects was significant and highly significant respectively indicating the importance of genotype by environment interaction for the trait (Tables 2 and 6). The maximum total fruit yield was recorded from Melkasalsa variety (19.64 t ha^{-1}), (25.49 t ha^{-1}) and (22.57 t ha^{-1}) at Wayu Tuka, Bako Tibe and combined analysis respectively. The minimum total fruit yield was recorded from Metadel variety (6.38 t ha^{-1}) at Wayu Tuka experimental site and Eshet variety (15.11 t ha^{-1}) at Bako Tibe experimental site. Whereas for combined analysis the minimum total fruit yield was recorded from Metadel variety (11.03 t ha^{-1}) which is statistically similar with Fetan variety (13.74 t ha^{-1}) (Table 6).

This could be due to the climatic conditions (i.e. the temperature, the soil type, the altitude) difference in which the crop was evaluated. On the other hand, the increase in total fruit yield could be due to variation in plant height, as well as formation of more primary, secondary and tertiary branches that increase potential of fruit bearing buds, also leaf area that maximizes photosynthetic capacity, and assimilate partitioning to the pods. The variation in total yield of tomato might be due the variation in the genetic makeup of different cultivars, though genotype x environment also contributes.

The results are generally in agreement with [9] and [18] who reported that total fruit yield of tomato ranging from 6.46-82.50 t ha^{-1} in their studies. Other reports on tomato fruit yield differences among cultivars include that of [32] who reported minimum and maximum yield of 15907 kg ha^{-1} and 42908 kg ha^{-1} respectively. [20] recorded average fruit yield of tomato in a range of 135.10 – 1046.80 q ha^{-1}. According to this author, genotypes with medium and large numbers of fruits per plant produced more fruit yield as compared with those with large fruit sizes but smaller number of fruits per plant.

Table 6. Mean values of unmarketable fruit yield and total fruit yield of tomato varieties at Wayu Tuka and Bako Tibe farmer's field, during 2018/2019 under irrigation.

Tomato varieties	Unmarketable fruit yield (t ha^{-1})			Total fruit yield (t ha^{-1})		
	Wayu Tuka	Bako Tibe	Mean	Wayu Tuka	Bako Tibe	Mean
ROMA VF	0.54	0.47	0.50	17.20^{b}	23.28^{b}	20.24^{b}
Bishola	0.49	0.33	0.41	7.82^{f}	16.21^{g}	12.02^{h}
Miya	0.44	0.74	0.59	16.83^{b}	22.37^{c}	19.60^{c}
Eshet	0.43	0.45	0.44	11.31^{d}	15.11^{h}	13.21^{ef}
Galilema	0.53	0.69	0.61	14.13^{c}	20.36^{d}	17.25^{d}
Melkashola	0.55	0.66	0.60	16.66^{b}	21.91^{c}	19.28^{c}
Chali	0.43	0.41	0.42	7.85^{f}	18.22^{e}	13.03^{fg}
ARP tomato d2	0.4	0.60	0.50	8.00^{f}	17.14^{f}	12.57^{gh}
Fetan	0.54	0.49	0.51	9.43^{e}	18.05^{e}	13.74^{e}
Cochora	0.43	0.63	0.53	16.54^{b}	18.14^{e}	17.35^{d}
Melkasalsa	0.84	0.78	0.81	19.64^{a}	25.49^{a}	22.57^{a}
Metadel	0.37	0.33	0.35	6.38^{g}	15.67^{hg}	11.03^{e}
LSD (5%)	0.25ns	0.34ns	0.21ns	0.96	0.76	0.59
Mean	0.49	0.55	0.53	12.65	19.33	15.99
CV (%)	30.2	36.65	33.78	4.46	2.31	3.15

Means within a column sharing common letter(s) are not significantly different at P=0.05., NS= Non significance difference LSD= Least significance difference CV=coefficient of variation.

3.5. Quality Parameters of Tomato Varieties

3.5.1. Total Soluble Solid (TSS%)

The analysis of variance for total soluble solid showed highly significant ($p<0.01$) differences among 12 tested tomato varieties at both experimental sites; moreover, effect of location, and interaction effect of location by variety was highly significant indicating the importance of genotype x environment interaction and need of testing varieties over different environments for adaptability (Table 2). The total soluble solid contents of fruit is one of the major criterions in selecting of tomato variety for fresh market as it determines the sugar and acid content of a fruit that influences the overall flavor of the fruit [33]. The maximum total soluble solid was recorded from Cochora variety (5.27) which is statistically similar with Chali (4.97) and Melkashola (5.00) while the minimum total soluble solid was observed from Galilema (3.27) at Wayu Tuka location. Whereas the maximum total soluble solid was recorded from Bishola variety (5.63) while the minimum total soluble solid was observed from Eshet (3.40) and it is statistically similar with Galilema (3.53), Melkashola (3.50) at Bako location (data not shown). However, for combined analysis over the two locations, the maximum total soluble solid was recorded from ARP tomato D_2 (4.85) and Chali varieties (4.76) while the minimum total soluble solid was recorded from Galilema variety (3.40).

The present results agreed with the findings of [34] who reported that TSS of cultivated tomato comprised 4.0-7.5% of its fresh weight. On the other hand, [35] reported that TSS for different tomato varieties grown under protected condition varied from 3.60-3.83%. TSS of tomato fruit are influenced mostly by the genetic makeup of the variety, in addition to environmental influence. Higher amounts of TSS are correlated with higher recovery product yield [20, 21, 36].

3.5.2. pH Value

The pH value is the other quality parameter, which determines the flavor and sourness of the juices made from tomato fruit. In the present study there was highly significant (*P<0.01*) difference in pH value of juices of the 12 tested tomato varieties at Wayu Tuka and Bako Tibe experimental sites, moreover, the location effect, location x genotype interaction effect was highly significant for pH value of the juices indicating environment contributes to the total variation (Table 2). Juices made from Galilema, Melkashola, Eshet and Bishola were acidic with the pH values of (4.03) at Wayu Tuka (data not shown). At Bako Tibe experimental site, Galilema was strong acidic with the pH value (3.70). Moreover, for combined analysis juices made from Galilema was strong acidic with the pH value (3.86) when compared to other varieties.

The present study result showed that tomato fruit pH ranged from 3.86 to 4.63 for the interaction of location and variety (Figure 4). The findings of this study are generally in agreement with the findings of [35] where tomato fruit juices were categorized as acidic with the pH value generally less than 5. Low pH values of tomato juice are associated with high fruit quality, which is accounted to the flavor, and sourness of the fruits. The genetic makeup of a variety determines the pH of the fruits and thus the flavor and sourness of the fruits [33].

3.5.3. Fruit Dry Matter Content (%)

The analysis of variance for fruit dry matter content showed highly significant (P<0.01) differences among the 12 tested tomato varieties at both locations; and the interaction effect of variety x location was also highly significant (Table 2). The highest fruit dry matter content was recorded from Chali variety (2.71) which is not significantly different from ARP D2 variety (2.64) and Melkasalsa (2.57) at Wayu Tuka. Similarly, highest fruit dry matter content was recorded from ARP D2 variety (3.53) at Bako Tibe experimental site while the smallest fruit dry matter content was recorded from Galilema variety (1.84) and (1.04) at Wayu Tuka and Bako Tibe experimental sites, respectively. Similarly, for over location analysis the highest fruit dry matter content was recorded from ARP D2 variety (3.08) and the smallest was recorded from ROMA VF variety (1.22) (Figure 5).

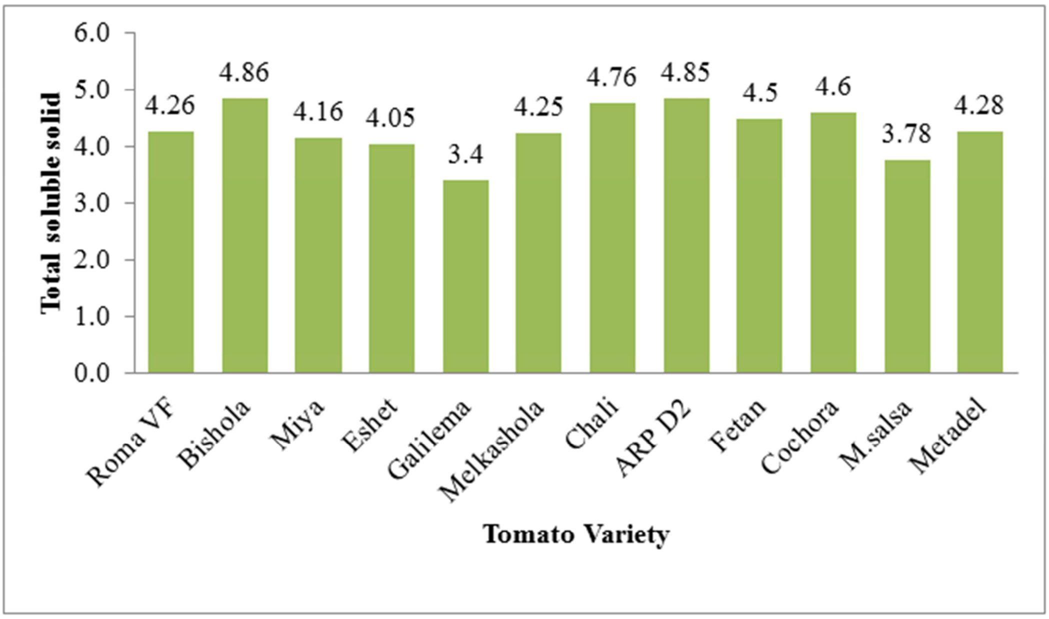

Figure 3. Mean values for total soluble solid of tomato varieties grown at Wayu Tuka and Bako Tibe districts of Western Ethiopia, (CV =5.1%; Mean= 4.31 and LSD (5%)= 0.25).

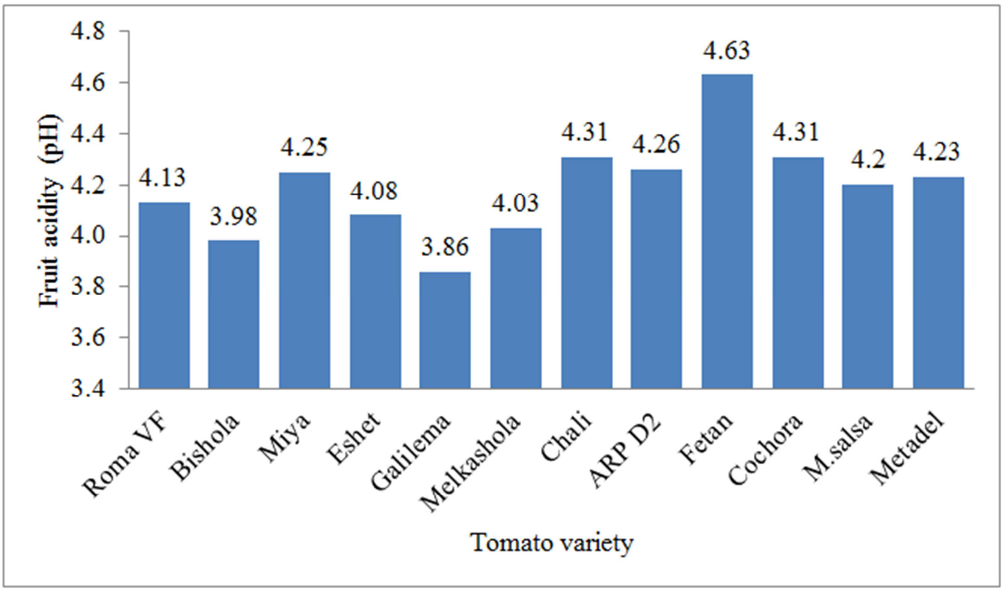

Figure 4. Mean values for fruit acidity (pH) of tomato varieties grown at Wayu Tuka and Bako Tibe Districts of Western Ethiopia, (CV=1.95%); mean=4.19 and LSD (5%) = 0.09).

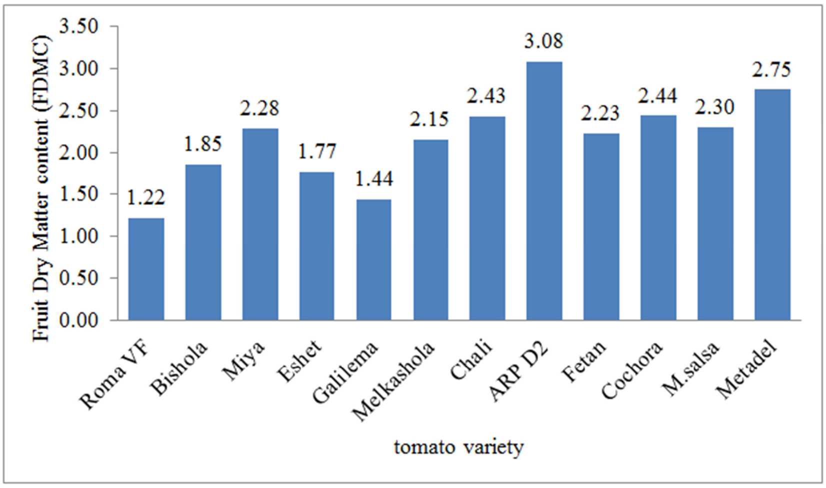

Figure 5. Mean values for fruit dry matter content (FDMC) of tomato varieties grown at Wayu Tuka and Bako Tibe Districts of Western Ethiopia (CV=10.0%); mean=2.16 and LSD (5%) = 0.25).

3.6. Phenotypic Correlation Coefficients of Tomato Characters

The results from combined analysis for the two locations of the correlation coefficients among agronomic and fruit quality characters of tomato are presented in Table 7. Positive and significant association was observed between days to flowering and days to maturity (0.95**). Number of fruits per plant correlated positively and significantly with NTPP (r=0.99**), NFPT (r=0.77**), MFY (r= 0.84**), UMFY (r=0.39**) and TFY (r=0.83**). Number of truss per plant showed positive and significant association with NFPP (r=0.99**), NFPT (r=0.87**), MFY (r=0.96**), UMFY (r=0.79**) and TFY (r=0.95**), PLH (r=0.37**) and NPBPP (r=0.61**). Marketable fruit yield correlated positively and significantly with PLH (r=0.37**), NPBPP (r= 0.58**), NFPP (r=0.84**), NTPP (r=0.82**) and NFPT (r=0.77**). This suggested that improvement in these traits will result in increased fruit yield. The results of the present study agreed with the findings of [37] who observed that yield had significant and positive correlation with fruits per plant, number of primary branches, plant height and fruit per bunch.

On the other hand, negative and significant association was observed between trait pairs. Single fruit weight correlated negatively and significantly with NFPP (r=-0.37**), NTPP (r=-0.41**), NFPT (r=-0.37**), MFY (r=-0.5**), UMFY (r=-0.39**) and TFY (r=-0.51**). Total soluble solids also showed negatively significant association with DF (r=-0.26*), DM (r=-0.27*), PLH (r=-0.25*), NFPP (r=-0.28*), NTPP (r=-0.26*), NFPT (r=-0.33*), MFY (r=-0.27*), UMFY (r=-0.29*) and TFY (r=-0.27*). The strong associations between pairs of traits might be due to linked genes and /pliotrophic effect of a single gene affecting the two traits at a time. Therefore, simultaneous improvement can be done through selection for such types of traits.

Table 7. Phenotypic correlation coefficients among tomato traits studied over combined locations.

Traits	DM	PLH	PBP	NFP	NTP	NFPT	NLPF	SFW	MFY	UMFY	TFY	FDMC	TSS	pH
DF	0.91**	-0.16	-0.15	-0.18	-0.17	-0.24	-0.08	0.07	-0.197	0.095	-0.196	0.13	-0.26*	-0.29*
DM		-0.07	-0.08	-0.04	-0.04	-0.099	0.033	0.005	-0.05	0.19	-0.05	0.09	-0.27*	-0.28*
PLH			0.65**	0.43**	0.37**	0.42**	0.48**	0.38**	0.37**	0.01	0.36**	-0.19	-0.25*	-0.22
PBP				0.62**	0.61**	0.37**	0.14	0.13	0.58**	0.025	0.57**	0.07	-0.12	-0.18
NFP					0.99**	0.77**	-0.098	-0.37**	0.84**	0.39**	0.83**	0.18	-0.28*	-0.24
NTP						0.73**	-0.13	-0.41**	0.82**	0.38**	0.82**	-0.15	-0.26*	-0.19
NFPT							-0.02	-0.37**	0.77**	0.39**	0.77**	-0.31**	-0.33*	-0.32*
NLPF								0.59**	-0.18	-0.19	-0.19	-0.06	0.03	-0.04
SFW									-0.5**	-0.39**	-0.51**	0.02	0.04	-0.13
MFY										-0.39**	0.99**	-0.17	-0.27*	-0.23
UMFY											0.42**	0.01	-0.29*	-0.07
TFY												-0.17	-0.27*	-0.22
FDMC													0.29*	0.42**
TSS														0.25*

* = Significant at P < 0.05, ** = Significant at P < 0.01, DF= Days to 50% flowering, DM= Days to maturity, PLH= Plant height, NPB= Number of primary branches per plant, NFP= Number of fruits per plant, NTP= Number of trusses per plant, NFPT= Number of fruits per truss, NLPF= Number of locules per fruit, SFW= Single fruit weight, MFY= Marketable fruit yield, UMFY= Unmarketable fruit yield, TFY= Total fruit yield, FDMC=Fruit dry matter content, TSS=Total soluble solids.

4. Summary and Conclusion

Evaluation of tomato varieties for its adaptability for marketable fruit yield and quality parameters is very important at Bako Tibe and Wayu Tuka districts of Western Ethiopia. The two districts have the potential for production of tomato since offseason production through irrigation is also possible in the districts. Therefore, an experiment was designed with the objectives to evaluate tomato varieties for marketable yield and quality parameters and to estimate the magnitude of associations of traits for possible indirect selection for higher marketable yield. Twelve tomato varieties have been used for this study. The experiment was laid out in randomized complete block design with three replications. The experiment was done during offseason of 2018/2019 under irrigation condition. Seedlings were raised on raised beds before transplanting to the experimental fields. Transplanting was done for the seedlings at 4-5 leaf stage. All other non-variable were applied uniformly to the experimental units. Data were recorded for agronomic and quality parameters of the tomato and analyzed using GLM procedures of SAS and means were tested for their significance using LSD test of Fisher's Statistics. Single location and combined over two locations were done.

The results indicated that yield and fruit quality parameters were significantly different among the tomato varieties evaluated. There was significant difference among the tomato varieties in all parameters at each location except for unmarketable fruit yield at Wayu Tuka, Bako Tibe and combined analysis.. Similarly, location, and location by genotype interaction had significant effect on all parameters indicating the two locations had different climatic and soil conditions; and the performance of the varieties could be different in different environments. Following the present findings, promising tomato genotype based on their marketable fruit yield was Melkasalsa (18.8tha^{-1}) followed by ROMA VF (16.66t ha^{-1}), Miya (16.39t ha^{-1}) and Melkashola (16.11t ha^{-1}) at Wayu Tuka condition. Tomato genotypes Melkasalsa (24.71t ha^{-1}), ROMA VF (22.8 t ha^{-1}), Miya (21.62t ha^{-1}) and Melkashola (21.25t ha^{-1}) showed superior yield performance at Bako Tibe condition. Across the two locations, Melkasalsa (21.76t ha^{-1}), ROMA VF (19.73t ha^{-1}), Miya (19.01t ha^{-1}) and Melkashola (18.68t ha^{-1}) were superior genotypes for marketable fruit yield.

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