International Journal of Research Studies in Science, Engineering and Technology
Volume 6, Issue 11, 2019, PP 1-9
ISSN : 2349-476X

Estimation of Genetic Component and Heritability for Quantitative Traits in Amaro Coffee (Coffea Arabica L.) Landrace at Awada, Southern Ethiopia

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ABSTRACT

Fifty eight Amaro coffee (Coffea arabica L.) accessions and six standard check were evaluated for genetic variability and character association at Awada Agricultural Research Sub-Center, Southern Ethiopia using morphological traits. The experiment was laid out in an 8x8 simple lattice design with eight coffee accessions per each incomplete block. The mean square for 19 quantitative characters revealed significant difference (P<0.05) among the accessions in coffee bean yield, plant height, height up to first primary branch, main stem diameter, canopy diameter, number of bearing primary branches, fruit width, fruit length, bean thickness, bean width, leaf width, 100-coffee beans weight, coffee berry disease and coffee leaf, average inter nodes length of main stem, length of first longest primary branch, number of primary branches, bean length, leaf size. High phenotypic and genotypic coefficient of variation was recorded for coffee bean yield, coffee berry disease and coffee leaf rust disease severity. Genotypic coefficients of variation were very close to their corresponding estimates of phenotypic coefficient of variation suggesting greater role of the genotype in the expression of these traits. High estimates of heritability and genetic advance as percent of mean observed for coffee berry disease, coffee leaf rust and bean yield. Coefficient of variation, heritability estimates, confirmed presence of variation among tested accessions. However, additional traits of interest should be studied over year and locations including physiological, quality and biochemical analysis with the support of advanced molecular techniques.

Keywords: *Coefficient of variation, Heritability, genetic advance*

INTRODUCTION

Naturally occurring genetic variability is useful in any plant breeding program. Variability is the amount of the total genotypic and phenotypic variability that exists in a crop germplasm; dictates the initiation of crop improvement programs and develops better varieties. Of the total variability present in a population the genetic component is most important to the breeder, as it could be transmitted to the progeny. In addition, proper management of this type of variability can produce permanent gain in the performance of the crop concerned (Mayo, 1980 and Welsh, 1990). Phenotypic variability is the observable traits of variation present in a population; and it is a combined effect of genotypic value and environmental deviation. Genotypic variations, on the other hand, is the component of variation, which is due to the genetic differences among individuals within a population, and is the main concern of plant breeding (Singh, 2001).

In Ethiopia the geographic allocation of coffee within its homeland is good indication for the existence of genetic variation within a population. Variability in coffee Arabica has been reported to exist in different locality, where the crop is grown. Different cultivars have been distinguished on the basis of morphological (plant height, branching habit, leaf color, leaf shape internodes length bean size and stem girth). Wide range of variability with respect to these characters has been observed for different accessions. Such traits of variability could enable Ethiopian coffee breeders to screen for coffee berry diseases resistant varieties and heterotic hybrid cultivars through crossing. Yigzaw (2005) reported that the estimates of PCV and GCV in coffee accessions for 18 quantitative characters ranged from 4.5 to 53.4% and 3.3 to 51.7%, respectively. Similarly, Olika *et al*. (2011a) and Getachew (2012) have reported high PCV and GCV values for coffee berry disease reaction and yield per tree; moderate PCV and

GCV values for height up to first primary branch and hundred bean weights.

Information on the nature and magnitude of variability and heritability in a population is one of the prerequisites for successful breeding program in selecting genotypes with desirable characters (Dudly and Moll, 1969). It is, therefore, of great importance for breeders to know the heritability of the agronomical characters to improve the yield of the crop effectively. According to Falconer and Mackay (1996), heritability is defined as the measure of correspondence between breeding values and phenotypic values. Thus, heritability plays a predictive role in breeding, and expressing the reliability of phenotype, as a guide to its breeding value. It is the breeding value which determines how much of the phenotype would be inherited in to the next generation (Tazeen *et al.,* 2009).

Heritability can be either broad sense or narrow sense. The broad sense heritability is the relative magnitude of genotypic and phenotypic variance for the traits and it gives an idea of the total variation accounted to genotypic effect (Allard, 1960). This gives an idea of the total variation ascribable to genotypic effects, which are exploitable portion of variation. Heritability in the narrow-sense is important as it affects genetic gain that depends on the proportion of additive genetic variance to phenotypic variance (Falconer and Mackay, 1996). It can also be used to establish the proper weighting of information from different types and numbers of relatives to achieve the best estimate of breeding value.

There is a direct relationship between heritability and response to selection, which is referred to as genetic advance. High genetic advance with high heritability estimates offer the most effective condition for selection (Larik *et al.,* 2000). The utility of heritability therefore increases when it is used to calculate genetic advance, which indicates the degree of gain in a character obtained under a particular selection pressure. Breeding for the most effective yield component, through yield improvement can be achieved, if the component traits are highly heritable and positively correlated with yield**.** However, it is very difficult to assess whether observed variability is highly heritable or not, due to polygenic nature of quantitative traits. Likewise, knowledge of heritability is essential for selection based improvement, as it indicates the extent of transmissibility of a character into future generations (Sabesan *et al*., 2009, Ullah *et al*., 2011).

Genetic advance expected from selection refers to the improvement of characters in genotypic value for the new population compared with the base population under one cycle of selection at a given selection intensity (Singh, 2001). Since high heritability does not always indicate high genetic gain, considering both heritability and genetic advance need to be used in predicting the ultimate effect for selecting superior varieties (Ali *et al*., 2002). Genetic advance gives clear picture and precise view of segregating generations for possible selection. Higher estimates of heritability coupled with better genetic advance confirms the scope of selection in developing new genotypes with desirable characteristics (Ajmal *et al.*, 2009).

Generally, about fifty eight coffee accessions were collected from Amaro Kele Woreda, but not yet tested for genetic component and heritability estimation. Therefore, this study was carried out with the objectives of estimating the magnitude of phenotypic or genotypic variance, heritability and expected genetic advance using different agro-morphological traits.

MATERIALS AND METHODS

Description of Experimental Site

The experiment was carried out at Awada Agricultural Research Sub-Center that was established in 1997 on land area of 31 ha near Yirgalem town, 45 km south of Hawassa and 319 km from Addis Ababa. Awada is located at 06°44′ 57’’ N latitude and 038°23’16’’E longitude and at an altitude of 1738 meters above sea level (m.a.s.l). The mean annual rainfall of the area is 1342 mm with an average maximum and minimum air temperatures of 28.4 °C and 11.°C, respectively.

Planting Materials and Experimental Design

About 64 coffee accessions including six pure line checks (Angafa, Feyate, Koti, Odicha, 74112 and 7440) were used for the study. The experiment was superimposed in the 2017/18 cropping seasons on three years old coffee trees planted on July, 2014. The trial was laid out in an 8X8 simple lattice design with two replications and six genotypes per each incomplete block. Each plot consisted of six coffee trees. Spacing between rows and among plants was 2mx2m. All the management practices were applied as per the recommendation for the crop.

Methods of Data Collection

During the course of this study, data on 23 quantitative characters, namely: plant height (cm), stem diameter (cm), number of main stem nodes (no), canopy diameter (cm), average inter node length of main stem (cm), average length of primary branches (cm), average inter node length of longest primary branches (cm), number of primary branches(no), percentage of coffee bearing primary branches (%), height up to first primary branches (cm), leaf length (cm), Leaf width (cm), leaf area (cm2), fruit length (mm), fruit width (mm), fruit thickness (mm),hundred green bean weights (g), green bean yield per tree (g), bean length (mm), bean width (mm) and bean thickness (mm) were collected from four sample trees per row on each accession traits were collected, using the standard coffee descriptor of IGPRI (1996). Coffee berry disease severity and Coffee leaf rust disease severity in percentage were also recorded through visual assessment per four trees.

Statistical Analysis

All quantitative data was subjected to analysis of variance using the SAS software version 9.3 (SAS, 2014). Analysis of Variance for 8 X8 simple lattice designs were done using the mean of sample data for the characters and mean comparisons among accessions were conducted at 5% levels of significance. The 8 X8 simple lattice design analysis of variance was used to derive variance components (Cochran and Cox, 1957).

Estimation of Genetic Components

Different genetic parameters including genotypic variance (σ^2g), phenotypic variance (σ^2p), phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were estimated using the formula adopted from Burton and De Vane (1953). *GCV* and *PCV* values were categorized as *low* (0-10%), *moderate* (10-20%) and *high* (20% and above) values, as indicated by Burton and De Vane (1953). Broad sense heritability values were estimated based on the formula of Falconer and Mackay (1996) as followed:

Heritability in broad sense (H^2b) = $\frac{\sigma^2 g}{\sigma^2 p}$ x 100. Where, H =heritability in broad sense. Then, the genetic advance for selection intensity (k) at 5% (2.063) was estimated by the following formula **(**Allard, 1960). Genetic advance as percent of mean was calculated to compare the extent of predicted advance of different traits under selection, using the following formula

GAM = $\frac{k*}{\bar{x}}\sqrt{\sigma^2 p} * H2$ **X 100** (Falconer and Mackey, 1996).

RESULTS AND DISCUSSION

Analysis of Variance

Analysis of variance (ANOVA) of 25 quantitative characters revealed that there was significant difference (P<0.05) among the accessions for most of the measured quantitative characters including clean coffee yield, during the 2017/18 cropping season (Table 1). The mean square showed that there was highly significant difference (P<0.01) among the coffee accessions for characters like: coffee bean yield, plant height, height up to first primary branch, main stem diameter, canopy diameter, number of bearing primary branches, fruit width, fruit length, bean thickness, bean width, leaf width, 100-coffee beans weight, coffee berry disease and coffee leaf rust. On the other hand, the traits that showed significant (P<0.05) level of difference includes: - average internode length of main stem, length of first longest primary branch, number of primary branches, bean length and leaf size.

This indicates the existence of substantial amount of variability among the tested genotypes selection that can be exploited to identify the best performing genotypes for future use. The significant difference observed for measured quantitative traits in this study were in agreement with the finding of earlier authors who reported considerable genetic variability within the Arabica coffee population for yield, disease resistance and growth characters. Mesfin and Bayetta (2008) reported the existence of difference among 100 Hararge coffee accessions using 14 quantitative characters. Similarly, Olika *et al.*, (2011b) found that significant difference for 22 quantitative characters studied on 49 coffee accessions. Bayetta (1997) reported high genetic variability within the Arabica coffee population for yield, CBD resistance and growth characters. In addition, the existence of variability among Arabica coffee accessions was further confirmed by many other researchers who reported significant differences among coffee germplasm collected from major coffee growing regions of Ethiopia (Yigzaw, 2005; Getachew *et al.*, (2013) and Masresha (2018). The variability present for important traits in the present study clearly proved the possibility to bring considerable improvement mainly in coffee yield and resistance level to leaf rust through selection and hybridization.

Table1. *Analysis of variance (Mean squares) for 25 quantitative characters of 64 Arabica coffee accessions at Awada, Southern Ethiopia.*

Traits	Sum Square of Mean					CV (%)	RE (%)	P value
	Replication	Blocks in rep.(ad)(14)	Accession (un adjusted(63)	Accession (adjusted(63	Error			
Coffee bean yield (kg)	323107.50	99628.00	476876.00	420534.20**	106366.60	34.06	98.59	<0.0001
Plant height (m)	6340.80	431.90	437.62	406.10**	179.70	5.84	116.12	0.0018
Height up to first primary branch	0.78	7.23	18.72	15.33**	5.34	9.82	101.94	<0.0001
Stem diameter (cm)	2.20	0.20	0.38	0.36**	0.06	4.82	123.86	<0.0001
Length of longest primary branch (cm)	528.94	56.74	49.31	47.85*	20.82	3.97	121.27	0.0015
Number of primary branch	18.10	22.20	36.50	36.14*	12.24	5.12	107.36	0.0336
Number bearing of primary branch	455.3	32.24	37.00	32.11**	17.10	8.22	108.43	0.0026
Number of main stem node	7.80E-05	6.12	7.20	6.99ns	2.40	4.47	118.4	0.2729
Average Internodes length on main stem (cm)	2.94	0.25	0.28	0.25*	0.14	7.60	107.76	0.0169
Canopy diameter (cm)	309.7	120.9	201.6	191.43**	93.30	4.74	101.43	0.0049
Average length of primary branch (cm)	1292.2	12.72	33.12	24.21ns	17.83	4.83	93.64	0.1332
Number of node per primary branch	38.61	1.96	2.90	2.19ns	1.82	6.60	100.13	0.256
Average internodes length on primary branch (cm)	0.22	0.10	0.06	0.06ns	0.05	5.98	103.01	0.515
Fruit length (mm)	4.54	0.58	1.38	1.27**	0.27	3.31	113.80	<0.0001
Fruit width (mm)	3.99	0.29	0.46	0.34**	0.14	3.30	111.54	0.0007
Fruit thickness (mm)	0.08	0.48	0.34	0.25ns	0.21	3.82	114.2	0.2585
Leaf length (cm)	2.28	0.26	0.31	0.28ns	0.2	3.6	101.93	0.0827
Leaf width (cm)	0.05	0.06	0.11	0.08**	0.04	3.85	102.61	0.0086
Leaf size (cm^2)	50.5	12.04	18.93	15.13*	8.01	6.61	103.47	0.0111
Coffee berry disease (%)	121.7	196.5	658.8	544.3**	107.73	50.33	107.52	<0.0001
Coffee leaf rust (%)	244.2	97.93	127.99	125.9**	30.79	27.45	128.83	<0.0001
Hundred bean weight (g)	31.3	2.14	6.16	5.72**	2.03	9.75	100.06	0.0001
Bean length (mm)	7.01	0.22	.43	0.45*	0.27	5.2	96.5	0.0293
Bean width (mm)	0.19	0.03	0.15	0.13**	0.04	3.1	96.22	<0.0001
Bean thickness (mm)	0.28	0.03	0.09	0.08**	0.04	5.27	93.04	0.0022

Range and Mean Performance of Accessions

The mean and ranges for the 19 quantitative traits of the 64 accessions are presented in (Table 2). The performance of the accessions ranged widely for bean yield (24.0-2474.5 kg/ha), total plant height (190.8-266.7 cm), coffee berry disease severity (0.0-85.0%), coffee leaf rust severity (2.50.0-46.7%), canopy diameter (184.8-223.8cm), length of longest primary branches (93.4-125.9 cm), number of primary branches (62.0-76.0), hundred bean weight (11.2-19.8 g), number of bearing primary branches (41.0-58.0), average internodes length on main stem(3.60-5.7mm), fruit length(14.0-18.2mm), fruit width(10.1-12.3mm), leaf width(4.9-5.9cm), leaf size(36.0-49.1cm^2), bean length(5.5-7.1mm), bean thickness(3.1-4.3mm) and bean width (5.9-7.1mm).

Out of these important traits, highest ranges were obtained for bean yield/kg, coffee berry disease severity, total plant height, coffee leaf rust severity and canopy diameter, which played important role in the total variability of coffee accessions. These high range values for each trait of interest suggest that great opportunity to improve the various desirable traits without much effort through selection as short term strategy and through hybridization as long term strategy. Hence, there is an opportunity to find accessions with disease resistance and high yielding potential among the tested entries that perform better to utilize in coffee improvement program. This result was agreed with the finding of Yigzaw (2005), Olika *et al.* (2011a), Getachew *et al.* (2013) and Masresha (2018), who found a wide range of variation for most measured quantitative traits.

The higher range of variability with respect to coffee berry disease enabled Ethiopian coffee breeders in screening for coffee berry diseases resistant varieties and heterotic hybrid cultivars through crossing (Mesfin and Bayeta, 1984). These indicate that the presence of true genetic differences among accessions for coffee disease severity. Generally, the range and mean performance of the traits studied confirmed the presence of an enormous genetic variability between the tested accessions. Hence, there is an opportunity to find genotypes having disease resistance and high yielding potential among the tested entries that perform better than the existing varieties to utilize for the future coffee improvement program.

Genotypic and Phenotypic Coefficients of Variation

Estimates of genotypic (GV) and phenotypic variability (PV) are presented in (Table 2). According to Deshmukh *et al.* (1986), phenotypic and genotypic coefficients of variation values greater than 20% are considered as high, whereas values less than 10% are considered to be low and values between 10 and 20% are considered as medium. Accordingly, the highest PCV and GCV were recorded for coffee bean yield, coffee berry disease and coffee leaf rust. Hundred bean weights and height up to first primary branch were characterized by moderate PCV and low GCV values. For most of the traits genotypic coefficients of variation were very close to their corresponding estimates of phenotypic coefficient of variation, suggesting the greater role of the genotype in the expression of these traits. PCV was much higher than GCV for coffee berry disease, coffee leaf rust and coffee bean yield indicating the higher influence the environment has on these traits.

The present finding illustrated that, PCV was higher than GCV for all studied quantitative traits, suggesting the observed variation in the coffee accessions were both the combination of genotypic and environment effect. The extent of the environmental influence on any character is indicated by the magnitude of the differences between the genotypic and phenotypic coefficients of variation. Large differences reflect high environmental influence, while small differences reveal high genetic influence (Akinwale *et al.*, 2011). For most of the traits genotypic coefficients of variation were very close to their corresponding estimates of phenotypic coefficient of variation, suggesting the greater role of the genotype in the expression of these traits. However, PCV was much higher than GCV for coffee berry disease, coffee leaf rust and coffee bean yield indicating the greatest influence of the environment on these traits.

The findings of the present study are comparable with the results of Atinafu *et al.* (2017) who reported that the estimates of PCV and GCV in 124 Sidamo coffee accessions for the 19 quantitative characters ranged from 4.52 to 60.89% and 3.92 to 56.52%, respectively. The author also reported higher PCV (25.8, 60.89 and 43.35 and GCV (21.12, 56.52 and 30.79) values for coffee bean yield, CBD and CLR, respectively. Mesfin and Bayetta (2008) reported that the estimates of PCV and GCV in

100 Hararghe coffee accessions for the 14 quantitative characters ranged from 5.9 to 54.8% and 3.2 to 37.5%, respectively.

Similarly, a previous research conducted on 16 coffee genotypes for 18 quantitative characters revealed that the PCV and GCV ranged from 4.5 to 53.4% and 3.3 to 51.7%, respectively (Yigzaw, 2005). Getachew (2012) also reported high PCV (91.5 and 41.7%) and GCV (62.8 and 22.1%) values for CBD reaction and yield per tree, respectively. Olika *et al.* (2011a) reported lower values of PCV (6.11, 6.31, 4.86, 5.51, 7.23 & 7.21) and GCV (5.31, 5.21, 3.86, 4.42, 5.76 &4.98) for bean length, bean width, fruit length, fruit width, plant height and canopy diameter respectively. Unlike in this result, Atinafu *et al.*, (2017) reported moderate PCV (13.28%, 14.18%, 16.74%, 11.16%, 14.23% & 15.00%) and GCV (11.11%, 12.97%, 15.57%, 13.41% & 13.66) for plant height, stem diameter, number of main stem node, canopy diameter, number of primary branch and number of bearing primary branch respectively.

The slight difference in the ranges of these previous studies and this could be due to the differences in the number of genotype studied, age of coffee and environmental conditions under which the genotypes were tested. From the high GCV values in this study it can be deduced that coffee berry disease reaction, coffee leaf rust reaction and coffee bean yield have high amount of exploitable genetic variability. It also signifies that there is greater potential for favorable advance in selection in these attributes when compared to other characters. The present finding is in agreement with the findings of Olika *et al.* (2011a) and Getachew (2012) who reported high PCV and GCV values for coffee berry disease reaction and yield per tree; moderate PCV and GCV values for height up to first primary branch and hundred bean weights.

Broad Sense Heritability and Genetic Advance

The estimate of the broad sense heritability for various characters of coffee ranged from 16.0% for coffee fruit thickness to 83.3% for stem diameter (Table 2) below. As suggested by Verma and Agarwal (1982) heritability estimates is low (<20%), medium (20-50%) and high (>50%). The recorded estimates of heritability were high (>50%) for stem diameter (83.3%), coffee berry disease reaction (80.2%), fruit length (78.7%), coffee leaf rust reaction (75.5%), coffee bean yield (74.7%), bean width (69.2%), number of primary branches (66.1%), number of main stem nodes (65.7%), height up to first primary branch (65.2%), hundred bean weight (64.5%), fruit width (58.8%), length of longest primary branch (56.5%), plant height (55.8%) and Canopy diameter (51.3%). A high heritability value indicates these traits were less influenced by the environment in their expression. Hence, selection based on phenotypic traits is effective. Moderate estimate of the broad sense heritability for Leaf width (50.0%), bean thickness (50.0%), leaf size (47.1%), number of bearing primary branches (46.8%), average internodes length on main stem (44.0%), bean length (40.0%) were observed from this study. This implies the possibility of using these traits in coffee improvement through breeding programs, because of good level of correspondence between genotype and phenotype.

These findings are in agreement with the previous work. For instance, Atinafu *et al.* (2017) reported the estimate of the broad sense heritability for various characters of coffee were high for coffee leaf rust reaction, The recorded estimates of heritability were high (>50%) for stem diameter, coffee berry disease reaction, canopy diameter, number of main stem nodes, plant height, number of primary branches, fruit length, hundred bean weight, average bean yield and coffee leaf rust reaction.

Similarly, Bayetta (2001) reported high heritability estimates for all characters measured in his study, and suggested greater effectiveness of selection and improvement to be expected for these characters in the future breeding program. Yigzaw (2005) has also observed high heritability for hundred green bean weight and canopy diameter. In contrast, Getachew (2012) reported moderately low heritability for fruit length, coffee berry disease severity, plant height, average inter node of main stem, leaf length, number of primary branches, average length of primary branches and clean coffee yield per tree. In this study, results are generally in agreement with most of the findings of previous studies.

The estimates of genetic advance as percent of mean (GAM) that could be expected from selecting of the coffee genotypes is presented in (Table 2). Johnson *et al.* (1955) stated that genetic advance as the percent of mean was categorized as low (0-10%), medium (10-20%) and high (≥20%). Accordingly, the higher value for GAM for coffee berry disease, coffee leaf rust and bean yield were recorded with respective values of 145.2, 89.3 and 73.8. Moderate GAM recorded on hundred bean weights (15.4%), stem diameter (14.3%) and height up to first primary branch (15.8%). Low GAM were recorded for morphological characters like:- fruit length, leaf width number of main stem node, fruit width, leaf size, leaf length, length of the first longest primary branch, number of node per primary branch, fruit thickness, canopy diameter, average length of primary branch, number of primary branches, number of bearing of primary branches, plant height, average inter node length of primary branch, average internodes length on maim stem, bean width, bean thickness and bean length (Table 2).

Similarly, Atinafu *et al.* (2017) reported that the GAM was higher for CBD, CLR, average coffee bean yield, and moderate for stem diameter. Unlikely, this author reported moderate GAM for average inter node length of stem, number of primary branches and plant height. Abdi (2009) also reported that the GAM was higher for coffee bean yield per plant and unlikely, for 100 bean weights higher GAM was reported by this author. According to Olika *et al.* (2011a), expected genetic advance as percent of the mean from selecting the top 5% of the genotype were high for height up to first primary branches and yield of coffee, whereas moderate GAM were reported for hundred coffee bean weight, number of primary branch, number of main stem node and leaf width in Arabica coffee accessions.

In addition, Yigzaw (2005) observed relatively high values of genotypic coefficient of variation, broad sense heritability and genetic advance for characters. Furthermore, the combined use of genetic coefficient of variation, heritability and genetic advance seems vital for effective improvement of a particular trait in a population. In this study, high estimates of heritability coupled with high genetic advance as percent of means were observed for characters such as coffee berry disease, coffee leaf rust and bean yield which revealed that most likely the high heritability are due to additive gene effects and improvement through selection based on phenotypic performance can be effective. Since high heritability does not always indicate high genetic gain, heritability with genetic advance considered together might be used in predicting the ultimate effect for selecting superior varieties. Genetic advance gives clear picture and precise view of segregating generations for possible selection. Higher estimates of heritability coupled with better genetic advance confirms the scope of selection in developing new genotypes with desirable characteristics.

Table2. *Estimates of components of variances, coefficient of variances, broad sense heritability (H2 %), expected genetic advance (GA) and genetic advance as percent of mean of Amaro coffee accession at Awada*

Traits	Range			Components of variances		Coefficient of variability		H^2 (%)	GA	GAM (%)
	Max	Min	Mean	$(\sigma^2 g)$	$(\sigma^2 p)$	GCV	PCV			
Coffee bean yield (kg)	2474.50	24.00	957.70	157083.80	210267.10	41.38	47.88	74.71	706.72	73.79
Plant height (cm)	266.70	190.80	229.60	113.20	203.05	4.63	6.21	55.75	16.39	7.14
Height up to first primary branch (cm)	31.00	16.70	23.50	5.00	7.67	9.51	11.78	65.17	3.72	15.84
stem diameter (cm)	5.90	4.20	5.10	0.15	0.18	7.59	8.32	83.33	0.73	14.30
Length of longest primary branch(cm)	125.90	93.40	114.98	13.52	23.93	3.20	4.25	56.49	5.70	4.96
Number of primary branch	76.00	62.00	68.30	11.95	18.07	5.06	6.22	66.13	5.80	8.49
Number bearing of primary branch	58.00	41.00	50.30	7.51	16.06	5.45	7.97	46.75	3.86	7.68
Number of main stem node	40.00	32.00	34.80	2.30	3.50	4.35	5.37	65.67	2.53	7.28
Average Internodes length on main stem	5.70	3.60	4.90	0.06	0.13	4.79	7.22	44.00	0.32	6.55
Canopy diameter(cm)	223.80	184.80	203.60	49.07	95.72	3.44	4.81	51.26	10.35	5.08
Average length of primary branch(cm)	98.00	78.30	87.68	3.19	12.11	2.04	3.97	26.35	1.89	2.16
Number of node per primary branch	22.80	17.60	20.50	0.19	1.10	2.10	5.10	16.89	0.36	1.78
Average internodes length on primary branch(cm)	4.70	3.70	4.30	0.01	0.03	1.64	4.03	16.67	0.06	1.38

Fruit length (mm)	18.20	14.00	15.30	0.50	0.64	4.62	5.21	78.74	1.29	8.46
Fruit width(mm)	12.30	10.10	11.20	0.10	0.17	2.82	3.68	58.82	0.50	4.47
Fruit thickness	12.95	11.15	11.98	0.02	0.13	1.18	2.95	16.00	0.12	0.97
Leaf length(cm)	13.05	11.25	12.14	0.04	0.14	1.65	3.08	28.57	0.22	1.82
Leaf width(cm)	5.90	4.85	5.34	0.02	0.04	2.65	3.75	50.00	0.21	3.86
Leaf size(cm^2)	49.10	36.00	42.80	3.56	7.57	4.41	6.43	47.06	2.67	6.24
Coffee berry disease	85.00	0.00	18.80	218.29	272.15	78.59	87.75	80.21	27.30	145.20
Coffee leaf rust	46.70	2.50	13.85	47.56	62.95	49.79	57.29	75.54	12.37	89.28
Hundred bean weight	19.80	11.20	14.60	1.85	2.86	9.30	11.58	64.51	2.25	15.42
Bean length(mm)	33.70	8.50	9.90	0.09	0.23	3.03	4.79	40.00	0.39	3.95
Bean width(mm)	7.10	5.90	6.40	0.05	0.07	3.31	3.98	69.23	0.36	5.69
Bean thickness(mm)	4.30	3.10	3.71	0.02	0.04	3.81	5.39	50.00	0.21	5.56

SUMMARY AND CONCLUSION

In this study, sixty four coffee accessions including six standard checks were evaluated in an 8X8 simple lattice design having two replications with eight genotypes per each incomplete block at Awada Agricultural Research Sub-Center.

The analysis of variance showed the presence of significant differences for most of the measured quantitative characters considered, indicating the existence of variability among the tested accessions. Phenotypic variance was higher than the genotypic variances for all the characters indicating the influence of the environmental factors on these traits. For most of the traits genotypic coefficients of variation were very close to their corresponding estimates of phenotypic coefficient of variation, suggesting the greater role of the genotype in the expression of these traits.

High heritability estimate was observed for stem diameter, coffee berry disease reaction, fruit length, coffee leaf rust reaction, coffee bean yield, bean width, number of primary branches, number of main stem nodes, height up to first primary branch, hundred bean weight, fruit width, length of longest primary branch, plant height and Canopy diameter. This suggests that these traits are primarily under genetic control and selection for them can be achieved through their phenotypic performance. High genetic advance as percent of means was observed for coffee berry disease, coffee leaf rust and coffee bean yield coupled with high heritability. This condition indicates that there is good opportunity to improve these traits using the tested accessions.

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Citation: *Desalegn Alemayehu, "Estimation of Genetic Component and Heritability for Quantitative Traits in Amaro Coffee (Coffea Arabica L.) Landrace at Awada, Southern Ethiopia", International Journal of Research Studies in Science, Engineering and Technology, vol. 6, no.11, pp. 1-9, 2019.*