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Correlation and Path Coefficient Analysis of Yield, and Yield attributes of Coffee (Coffea Arabica L.) Collections, at Southwest Ethiopia

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Abstract

Ethiopia is the birthplace of coffee. Arabica L., has a lot of genetic diversity, which assists with morphological characterization and the development of resistant and high-yielding coffee types. 133 coffee accessions from the Bale and West Arsi zones, as well as four replicated standard check varieties (74148, 74165, 74110 and 75227), were investigated for genetic diversity and character association at the Gera Agricultural Research Sub Center. The experimental treatment, which was laid out in an augmented design, consisted of three blocks of single row with six trees per plot. The experiment was conducted on four-year-old coffee trees. In the study, three representative trees per plot were used to collect data for 25 quantitative traits. The analysis of variance found that most of the quantitative traits analyzed had a significant ($P<0.05$) difference, and that most of the assessed traits had a broader range of variation. The proportion (%) of bearing primary branch (rg=0.64), coffee leaf rust (rg=0.39), and canopy diameter (rg=0.39) were all positive and statistically significant associated with coffee yield. Fruit thickness, canopy diameter, height to primary branch, percentage of bearing primary branch, and coffee leaf rust all had a direct positive impact on coffee yield. Canopy diameter, height up to primary branch, percentage of bearing primary branch and coffee leaf rust exhibited significant at both genotypic and phenotypic correlation and positive direct effect with coffee yield indicate that improvement of these traits directly improves coffee yield. Thus, selection for coffee green bean yield in coffee through these traits would be effective in order to increase the coffee production in Ethiopia.

Keywords: *Coffea arabica, variability, correlation, Path Coefficient Analysis.*

Introduction

Arabica coffee is the only natural allotetraploid (2n=4x=44) species in the genus Coffea, with its principal center of origin and genetic diversity in the highlands of south-west Ethiopia (Sylvain, 1955). The other coffee species are all diploid (2n=2x=22) and allogamous (Meyer 1965). The Coffea L. genus has 124 species (Davis et al., 2011). Only three species in the genus are economically valuable: C. arabica (Arabica coffee), C. canephora (Robusta coffee), and C. liberica (excels coffee) (Davis et al., 2006).Yield is one of economically vital characteristics in coffee genetic advancement.

Coffee is globally one of economically the most important exported commodities on the earth after oil (Pendergrast 1999). It provides one of the most widely drunk beverages in the world, and is a very important source of foreign exchange earnings for many countries. However, More than fifty developing countries are earning 25 % of their foreign exchange from coffee (ITC, 2002) and more than 125 million people in the world, derive their income directly or indirectly from its products in cultivation, processing, trading, transportation and marketing (Lashermes et al., 2011; Gray et al., 2013).

In Ethiopia Coffee is main export commodity, contributing to the livelihoods of more than 15 million smallholder farmers and other actors (USDA, 2022). Accordingly, 95% percent of coffee is produced by Smallholder farmers who own less than two hectares of land, while the remaining five percent grown on modern commercial farms (USDA, 2018). During the

2017/18 marketing year alone, Ethiopia registered a record of almost 917 million U.S. dollars from coffee exports (USDA, 2019). j

For coffee breeding projects, understanding the relationship between yield contributing traits and yield is crucial. Because Yield is a complicated substance whose inheritance is dependent on a multitude of features that are naturally polygenic and heavily impacted by natural causes (Nadarajan and Gunasekaran, 2005). It is also critical to collect data on the characteristics of agronomic significance when starting a breeding program with any crop with genetic variety in order to choose and breed superior varieties (Dubley and Moll, 1969). In any event, under-standing the relationships between distinct characteristics and yield, as well as their direct and indirect effects on one another, is the basis for a successful breeding program (Ali et al., 2003).

The correlation coefficient is applied to discover the degree (strength), the not unusual place courting among exclusive plant characters, and the aspect individual on which choice can rely upon the genetic development of yield (Khan and Dar, 2010). But facts at the relative importance of direct and indirect effects of every aspect characters toward yield is given through path coefficient study and that is accommodating in dividing the relationship into direct and indirect effects in order that relative contribution of every aspect individual to the yield may be evaluated (Singh and Narayanam, 2007).

Different researchers reported the presence of association between yield and its components. For example, Ermias H (2005) report average green bean yield exhibited significant and positive association with plant height; stem girth, number of primary branches, canopy diameter and average length of primary branches. (Atinafu and Mohammed, 2017) also report Average green bean yield exhibited positive and significant correlation with hundred green bean weight, stem diameter, angle of primary branch, canopy diameter, average length of primary branches, percent of bearing primary branches, leaf length and bean width, suggesting that yield per plant would increase with increase of these characters. Olika et al. (2011) have reported significant and positive genotypic correlations of coffee yield with plant height, canopy diameter, and percentage bearing primary branches, fruit length, hundred bean weight, leaf length, bean width and height up to first primary branches at genotypic level. Regarding, of path analysis (Atinafu and Mohammed, 2017) report the highest direct positive effect was shown by plant height (10.80) followed by leaf length (6.02), leaf width (5.99), hundred green bean weight (3.46), effect berry disease (2.93), percentage of bearing primary branches (2.40), stem diameter (2.21) and average length of primary branches (1.92).

However, as Coffee arabica L. is a plant that originated in Ethiopia and has a wide range of genetic variability that can be used to find yield-related traits for future coffee breeding programs. These coffee genetic resources are at threat due to improved varieties being developed and climate change. However, the Jimma Agricultural Research Center (JARC) has a total of 6923 coffee collections stored at the national coffee coordinating center (JARC) and its sub-centers from various coffee-growing regions around the country. However, phenotypic correlation, genotypic correlation and path coefficient analysis of coffee yield related traits that can best fit the needs has not yet been fully analyzed and computed for the bale and west arsi zone of Ethiopia coffee collections. Thus, the objectives of this study were to estimate the phenotypic and genotypic correlations among coffee yield and its related traits and to see the direct and indirect effects of these traits on coffee yield. .

MATERIAL AND METHOD

Description of the Study Area

The test was conducted at Gera Rural Investigate Sub Center. The center is found 425 km. southwest of Addis Ababa. Gera is found at 7046 N scope and 360 26’ E longitudes, at an elevation of 1974 meters over sea level. The cruel yearly precipitation of the region is 1880 mm with average greatest and least air temperatures of 24.5oC and 10.4oC respectively. The center has contained Acrisols and Nitoso soil with a pH of 5-6 and medium to high exchangeable cation (Paulos, 1994; Paulos and Tesfaye, 2000).

Planting Materials and Experimental Design

Around one hundred thirty-three C. arabica accessions which were collected from Bale and West Arsi Zone along with four coffee berry disease resistance (CBD) and high yielding pure line checks (74110, 74148, 74165, and 75227) were planted at Gera Agricultural Research Sub Center in July 2015. This study was super imposed on coffee plantations in 2018/19 on three years old coffee trees. The experiment was established in an augmented design with three replications. A plot is laid out in a single row with six trees. Spacing both, between rows and plants were 2m x 2m (plot area of $4m^2$) and spacing between block was 4 meter. All management practices were applied as per recommendation.

Data Collection

- ***Fruit Length (mm):*** average of five normal and mature green fruits of each tree was measured at the longest part using a digital caliper.
- ***Fruit Width (mm):*** average of five normal and mature green fruits of each tree were measured at the widest part using a digital caliper.
- ***Fruit Thickness (mm):*** average of five normal and mature green fruits of each tree were measured at the thickest part using a digital caliper.
- ***Coffee Bean Yield (kg/ha):*** weight of fresh cherries in gram per plot was harvested and the mean of six trees was converted into yield of clean coffee kg/ha.
- ***Height up To First Primary Branch (cm):*** height from the ground up to the first primary branch was measured using a tape meter
- ***Number of Primary Branches (no):*** total number of primary branches was counted per tree
- ***Number of the Secondary Branch (no):*** number of secondary branches on the primary branch was counted per tree.
- ***Percentage of Bearing Primary Branches (%):*** was computed per tree as (NBPB/NPB) * 100, where NBPB = number of bearing primary branches per tree, NPB = total number of primary branches per tree.
- ***Canopy Diameter (cm):*** Average length of tree canopy was measured twice, east-west and north-south direction by using a tape meter.
- ***Coffee Berry Disease (CBD):*** severity percentage was visually estimated as the percentage of diseased berries (damaged coffee berries over all barriers of bearing branch) by observing areas of infected parts of coffee berry from a whole coffee branch of six trees per plot.
- ***Coffee Leaf Rust (CLR):*** Severity was directly estimated as the percentage of leaves per tree (damaged leaves over all the top, middle and bottom part of the tree) by observing areas of infected parts of coffee leaf from a whole coffee branch of three trees per plot.
- ***Height up To First Primary Branch (cm):*** height from the ground up to first primary branch was measured using tape meter
- ***Number of Primary Branches (no):*** total number of primary branches was counted per tree
- ***Number of Secondary Branch (no):*** number of secondary branch on primary branch was counted per tree.
- ***Percentage of Bearing Primary Branches (%):*** was computed per tree as (NBPB/NPB) * 100, where NBPB = number of bearing primary branches per tree, NPB = total number of primary branches per tree.
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- ***Coffee Leaf Rust (CLR):*** Severity was directly estimated as the percentage of leaves per tree (damaged leaves over all the top, middle and bottom part of the tree) by observing areas of infected parts of coffee leaf from whole coffee branch of three trees per plot.

Statistical Analysis

Correlation analysis of variance was made using SAS software version 9.2 (SAS, 2010). The statistical computation of correlation coefficients was done to determine the degree of association of a character with yield and also among the yield components.

$$rp = \frac{a^2 p_{xy}}{\sqrt{\sigma^2 p_{\sigma^2 p_y}}}$$

Where, rp=phenotypic correlation coefficient, σ^2pxy=Phenotypic

Covariance between character x and y, σ^2px=Phenotypic variance for

Character x and σ^2py=Phenotypic variance for character y

$$rg = \frac{a^2 g_{xy}}{\sqrt{\sigma^2 g_{x_{\sigma^2 g_y}}}}$$

Where, rg=Genotypic correlation coefficient, σ^2gxy=Genotypic

Covariance between character x and y, σ^2gx=Genotypic variance for

Character x and σ^2gy=Genotypic variance for character y.

The coefficient of correlation at phenotypic level was tested for its significance with Table for simple correlation coefficient using n-2 df as su ggested by Gomez and Gomez (1984) or using" table, with observed t expressed as

$$t = \frac{r_{pxy}\sqrt{n-2}}{1 - r^2 pxy}$$

The coefficient of correlation at genotypic level was tested using the formula:

$t = r_{gxy}/SE_{rgxy}$

Where r_{gxy}= genotypic correlation coefficient, SErgxy=standard error

$$SE_{rgxy} \sqrt{\sqrt{\frac{1 - r^2 gxy}{2h1^2 h^2}}}$$

Where h_1^2 and h_2^2 are broad sense heritability for the character 1 and 2. Path coefficient analysis

Path Coefficient: analysis was carried out at genotypic level to evaluate a number of direct and indirect effects of independent variables on dependent variable which is not obtained by correlation study. A measure of direct and indirect effects of each component on bean yield was estimated using a formula rij =Pij+ Σrikpkj (Dewey and Lu 1959).

Where: - rij = Mutual association between the independent character (i) and dependent character (j) as measured by the correlation coefficient. Pij=Component of direct effects of the independent character (i) on dependent character (j) as measured by the path coefficient and, ∑ rikpkj = Summation of components of indirect effect of a given independent character (i) on the given dependent character (j) via all other independent character (k).

Residual effect (U) was estimated by the formula: U=√1 –R ^{2} =Where: - R^2=Σpijrij pij = Component of direct effects of the independent character (i) and dependent character (j) as measured by the path coefficient. rij = Mutual association between the independent character (i) and dependent character (j) as Measured by the correlation coefficient.

RESULT AND DISCUSSION

The mean square showed that there was significant difference differences among the accessions ($P<0.05$) for bean yield, fruit thickness, canopy diameter, fruit length, fruit width, coffee berry disease (CBD), Coffee leaf rust (CLR), number of secondary branches, percent (%) of bearing primary branch and height up to first primary branch (Table 1).Those traits are a good chance to improve the accessions through selection and breeding. This study result agrees with the findings of Olika et al., (2011) who found that significant variations among 49 accession for 22 characters. Atinafu (2015), Abdulfeta (2018) and Desalegn (2018) also found a substantial amount of variability for different traits among tested genotypes of arabica coffee, which shows the possibility to bring improvement through selection. Moreover, Mesfin and Bayyeta (2008) reported the mean square of treatment showing that significant difference among 100 Hararge coffee accession for 14 quantitative characters.

In the studied traits checks Versus accessions that compared 133-tested accession to the 4 standard checks were significant for all characters except stem diameter, number of primary branches, number of nodes on main stem, bean length, bean thickness, number of nodes on a primary branch (Table 1). This also showed that existence of variation between collected accessions and control check varieties.

Table1. *Analysis of variance Test within Accessions, Checks within and Checks vs Accessions for quantitative traits.*

Traits	Mean square						
	Blocks	All entries	Test within Accessions	Checks within	Checks vs Accessions	Error	CV
	(d.f=2)	(d.f=136)	d.f=132)	(d.f=3)	(d.f=1)	(d.f=6)	(%)
canopy diameter	608.23**	371.41**	345.29**	501.45**	3431.70**	47.26	4.19

fruit length (mm)	0.02 ns	1.76**	1.52**	0.47**	37.54**	0.02	0.93
fruit thickness(mm)	0.45 ns	0.50*	0.46 ns	0.27 ns	6.64**	0.14	3.11
fruit width (mm)	0.32*	0.52**	0.50**	0.52**	3.47**	0.05	1.64
coffee berry disease	446.10 ns	971.64**	919.73**	161.78 ns	10272.56**	166.24	34.52
coffee leaf rust	178.78**	69.39**	69.77**	25.83 ns	144.18**	8.22	32.40
yield (kg/ha)	10898.27 ns	395375.66*	400139.36*	217765.67 ns	305504.01*	114453.28	35.61
number of secondary branch	223.63	1642.99**	1644.49**	793.15	3994.35**	220.37	23.01
height up to first primary branch (cm),	3.00ns	46.84**	41.51**	19.48*	703.78**	3.72	6.05
% of bearing primary branch	53.36 ns	300.77**	298.85ns	16.85**	1423.53**	23.39	6.05

**, ** Significance at 0.05 and 0.01 level of probabilities, ns= non significance difference, df = degree of freedom, CV= coefficient of variation.*

Phenotypic and Genotypic Correlation

Genotypic and phenotypic correlation coefficien ts of computed quantitative traits were presented in Table 2. The result from this study revealed the coefficient of a genotypic correlation nearly closely related to the coefficient of phenotypic correlation. This shows the equal contribution of both environment and genetic for trait expression. Inapposite of the above result, Atinafu, and Mohammed, (2017) ; Beksisa et al., (2017) who reported, Phenotypic relationship result was showed up lower than the genotypic relationship coefficients for most of the character. Yield is positively and significantly correlated with the percent of bearing primary branch, height up to the first primary branch, canopy diameter, and CLR at both genotypic and phenotypic levels. This demonstrates the presence of close association with each other. Similarly, Olika et al., (2011) and Atinafu and Mohammed (2017) reported positive association between normal green bean yield with the percentage of bearing primary branch and canopy diameter. This discovery also concurred with Walyaro (1983) and Marandu et al., (2004) report in that coffee yield is influenced by most important characters like number of primary branches, canopy diameter, plant height and main stem diameter.

However, the association of other traits like height up to first primary branch (0.14), fruit length (0.01), number of secondary branch (0.03) was non-significant and positively correlated with yield (kg/ha) at both genotypic and phenotypic level. This indicated indirect selection based on any of these characters studied would not provide satisfactory gains for coffee yield. The inter-relationship of these characters may be due to the genotype or environment influence in different ways. Leaf rust (0.43) severity was positively correlated with coffee yield at both phenotypic and genotypic correlations. The result indicated that when the green coffees yield increase, CLR severity was also increased simultaneously. This might be because of the decreasing plant's resistance ability due to extensively utilize of stored food for yield increment. Accordingly, Plant arranges itself in order to develop leaf bud in the coming season rather than producing yield.

While, coffee berry disease (CBD) negatively (-062) correlated at both genotype and phenotype with coffee bean yield, this is because of different genes or a single gene that controls more than one trait (pleiotropic gene), that has dominated on the trait may control them in different directions (Kearsey and Pooni, 1996). These findings were agreed with Masreshaw, (2018) and Atinafu, (2017), who reported CBD showed negative correlation and none significant difference between coffee berry disease and coffee bean yield. In contrast of the current result Olika et al., (2011), Muvunyi et al., (2017) and Abdulfeta (2018) was reported yield is none significantly and positively correlated with CBD. Whereas, coffee leaf rust negatively correlated with fruit thickness (r = -0.19), coffee berry disease (r=-0.31), and height up to first primary branch at both genotype and phenotype association. This confirms that the improvement for negatively correlated trait antagonistically affects the other.

Fruit thicknesses were negatively none significantly correlated with yield and Percent (%) of bearing primary branch at both correlations. Whereas positively and significantly correlated with fruit length (rg=0.60), fruit width (rg=0.81), CBD (rg =0.25), number of secondary branch (rg = 0.19), height up to first primary branch (rg=0.16) and canopy diameter (rg=0.21). This indicated existence of true relationship among accessions based on measured quantitative traits. However, it had significant and negatively correlated with coffee leaf rust (rg =-0.19*). CLR (0.44) was showed positively and significantly correlated with percent of bearing primary branch (r = 0.39) at both correlations. Other traits such as: fruit thickness (rg = 0.61), fruit width (rg = 0.72), height up to first primary branch (rg = 0.32) and canopy diameter (rg = 0.20) were positively and significantly correlated with fruit length at genotypic level.

Generally, in this study some traits were positively and significantly correlated, as well as other significant and negatively correlated with yield and among each other. For positively associated traits simultaneously improvement of one trait will improve the other. Whereas, those traits, which were negatively correlated the improvement for one trait antagonistically affect the other. Such association might be raise because of additive or non-additive gen action and the other factors such as pleiotropic that could control the traits within the same direction (Welsh, 2008). Also negative correlation of traits might be because of different genes or pleiotropic gene that has dominance on the trait may control them in different direction (Kearsey and Pooni, 1996).

CBD severity reaction had significant and negative correlation with, coffee bean yields. Suggested, selection for any one of these characters is not likely to result in improvement of the others. However, independent selection may have to be carried for improvement this traits. These findings partially agree with Olika *et al.,* (2011) who found that positive and significant genotypic correlation of yield per tree with plant height, stem diameter, canopy diameter, fruit length, bean length, leaf length, bean width, bean thickness, bean width, hundred bean weights, percentage of bearing primary branches and height up to first primary branch.

Phenotypic and Genotypic Correlation among Morphological Traits

Table2. *Genotypic (above diagonal) and phenotype (below diagonal) correlation coefficient among 10 important characters.*

Variable	YLD	FL	FT	FW	CBD	RUST	NSB	HUFPB	CANOP	POBPB
YLD		0.01	-0.02	-0.01	-0.62**	0.44**	0.03	0.14	0.25**	0.64**
FL	0.01		0.61**	0.72**	0.11	-0.05	0.08	0.32**	0.20**	-0.01
FT	-0.02	0.60**		0.81**	0.25**	-0.19*	0.19*	0.16*	0.21**	-0.15
FW	-0.01	0.71**	0.80**		0.13	-0.05	0.14	0.23**	0.22**	-0.08
CBD	-0.62**	0.11	0.26**	0.13		-0.31**	0.34**	0.12	-0.04	-0.64**
RUST	0.43**	-0.04	-0.19**	-0.04	-0.31**		0.00	0.03	0.11	0.39**
NSB	0.03	0.08	0.19*	0.14	0.33**	0.00		0.22**	0.20*	-0.10
HUFPB	0.14	0.32**	0.15	0.23**	0.12	0.04	0.22**		0.34**	-0.04
CANOP	0.25**	0.20**	0.19*	0.20**	-0.05	0.11	0.20**	0.34**		0.20**
POBPB	0.64**	-0.01	-0.15	-0.08	-0.64**	0.39**	-0.10	-0.04	0.20**	

**, ** = Significant at 5% and 1%, probability level respectively, ns = no significant difference, YLD=yield (kg/ha), FL= fruit length (mm), FT= fruit thickness (mm), FW = fruit width (mm), CBD= coffee berry disease RUST= coffee leaf rust, NSB= number of secondary branch, HUFPB= height up to first primary branch, CD= canopy diameter, POBPB=percent (%) of bearing primary branch.*

Path Coefficient Analysis

The genotypic correlation coefficient of coffee y ield with its contributing components were partitioned into direct and indirect effects through path coefficient analysis (Table 3) in order to formulate a sound basis for selection of the important contributing characters to the coffee yield. Thus, path coefficient analysis is simply a standardized partial regression coefficient that partitions the correlation in to direct and indirect effects.

Hence, the use of this method requires cause and effect relationship among the variables, and the experimenter must assign direction in the casual system based up on priori grounds of experimental evidence. In this study the highest and positive direct effect of path coefficient analysis was recorded for fruit thickness (0.33) followed by percentage of bearing primary branch (0.29) and coffee leaf rust (0.22) (Table 7). However, the former trait showed higher and direct effect on coffee yield. But exhibited negative phenotypic correlation (-0.02) with coffee yield. The negative correlation it showed with coffee yield was mainly due to negative indirect effects via other traits: fruit length and CBD. Moderate magnitude of positive direct effect was recorded for height up to first primary branch (0.16) and number of secondary branches (0.15). This result also partially agrees with Getachew *et al*., (2013) who reported that fruit length, fruit thickness and height up to first primary branches showed a positive direct effect on yield. Lowest grade and positive direct effect were exhibited for canopy diameter alone (0.05). These showed that using of above positive traits may directly contribute to coffee yield increment.

The negative direct effect and positive correlation were recorded via fruit length (-0.018). The result of fruit width (-0.25) showed, positive direct effect and negative association with coffee yield. Whereas, CBD **(**-0.48) exhibited both negative association and direct effect on coffee yield. The negative indirect effect of above traits needs to be managed during selectionbecause the selection of traits might ha ve reduced effect on yield of coffee. Likewise, Masreshaw (2018) also report coffee berry diseases severity was a negative direct effect and negative correlation with yield per tree.

The positive direct selections have highly effecti ve for improvement of coffee yield than negative direct effect because its influence the coffee yield directly. Canopy diameter, height up to primary branch, percentage of bearing primary branch and coffee leaf rust exhibited significant at both genotypic and phenotypic correlation and positive direct effect with coffee yield indicate that improvement of these traits directly improves coffee yield. Desalegn (2018) reported positive direct effect of canopy diameter (0.41), height up to first primary branch (0.30), number of bearing primary branches (0.30) on coffee yield. The result was agreed with Beksisa *et al*., (2017) who reported that canopy diameter and height up to primary branch showed significant at both phenotypic and genotypic correlation and positive direct was effects recorded by canopy diameter on coffee yield.

Table3. *Direct and indirect effect of bean yield and yield contributing character.*

Variable	FL	FT	FW	CBD	RUST	NSB	HUFPB	CANOP	PBPB	rG
FL	**-0.018**	0.202	-0.176	-0.056	-0.010	0.012	0.053	0.010	-0.004	0.013
FT	-0.011	**0.333**	-0.200	-0.123	-0.042	0.028	0.027	0.010	-0.044	-0.022
FW	-0.013	0.271	**-0.246**	-0.061	-0.011	0.022	0.038	0.011	-0.024	-0.013
CBD	-0.002	0.085	-0.031	**-0.484**	-0.068	0.051	0.020	-0.002	-0.184	-0.616
RUST	0.001	-0.065	0.012	0.151	**0.216**	0.000	0.006	0.005	0.113	0.440
NSB	-0.001	0.062	-0.035	-0.163	0.000	**0.150**	0.037	0.010	-0.030	0.028
HUFPB	-0.006	0.055	-0.057	-0.059	0.007	0.033	**0.164**	0.017	-0.011	0.145
CANOP	-0.004	0.068	-0.053	0.019	0.023	0.030	0.056	**0.050**	0.057	0.247
PBPB	0.000	-0.051	0.020	0.311	0.085	-0.016	-0.006	0.010	**0.287**	0.640

FL= fruit length (mm), FT= fruit thickness (mm), FW = fruit width (mm), CBD= coffee berry disease RUST= coffee leaf rust, NSB= number of secondary branch, HUFPB= height up to first primary branch, CD canopy diameter, POBPB=percent (%) of bearing primary branch.

The residual effect permits precise explanation a bout the pattern of interaction of other possible components of yield. In other words, residual effect measures the role of other independent variables which were not included in the study on the dependent variable. In this study, the estimated residual effect was 0.66% indicating that about 0.34% of the variability in yield was contributed by the characters studied in path analysis. This residual effect towards yield in this study might be mainly due to the other character s which were not included in the investigation a nd environmental factor. Therefore, the aspect o f intensive germplasm exploration in the Bale and West Arsi coffee considering additional characters was suggested in order to confirm the results. In general, the path analysis carried out in the present study revealed that the main components of bean yield, which had positive direct effect of bean yield, should be given high priority for making selection.

Conclusion

The study revealed the coefficient of a genotypic correlation nearly closely related to the coefficient of phenotypic correlation. This shows the equal contribution of both environment and genetic for trait expression. Yield is positively and significantly correlated with characters like, percent of bearing primary branch, height up to the first primary branch, canopy diameter, and CLR at both genotypic and phenotypic levels. Which indicates the selection of these characters would give better response in yield. Selection of none significantly correlated traits on any of studied characters would not provide satisfactory gains for coffee yield improvement. However, leaf rust severity was positively correlated with coffee yield at both phenotypic and genotypic correlations. The result was indicated when the green coffee yield increase, CLR severity was increased simultaneously. According to the path analysis, accessions with higher fruit thickness, persons of bearing primary branch and canopy diameter should be given more weight in yield selection, as evidenced by their positive direct effects. High indirect effects of the characters were noticed through number of primary branch indicating importance of the character also as selection criteria in crop yield improvement programs. Hence, based on correlation and path analysis, the characters, Canopy diameter, height up to primary branch, percentage of bearing primary branch and coffee leaf rust exhibited significant at both genotypic and phenotypic correlation and positive direct effect with coffee yield indicate that improvement of these traits directly improves coffee yield. As a result, it is obvious that this study taught coffee breeders to focus their selections for coffee development on a small number of component characters. This can help reduce the time spent searching for additional component characters and increase breeding efficiency

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