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Correlation and path coefficient analysis of Cassava (*Manihot esculenta* Crantz) at Jimma, Southwestern, Ethiopia

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Abstract

Thirty-five accessions of cassava /Manihot esculenta Crantz/ were tested at Jimma Agricultural Research Center during the 2009-2011 growing seasons using three replications of RCBD. The objectives of the study were to investigate the interrelationship of yield related characters and extent of their contribution to fresh root yield on cassava. Correlation and path-coefficient were computed between plant height, number of vertical stem/plant, number of branches/plant, canopy diameter, stem girth, number of roots/plant, root length, roots diameter, root fresh weight, weight of above ground plant biomass and root dry weight in thirty five cassava genotypes. The phenotypic correlation between root fresh yield and plant height, canopy diameter, stem girth and roots diameter was highly significant, while positive and significant genotypic correlation was significant between these characters and root fresh yield plant. Among these characters, roots diameter reflected the highest direct effect of (1.978) towards root fresh weight; while minimum was indicated by plant height (-1.826). Plant height, number of roots/plant, number of vertical stem/plant and root diameter along with their indirect causal factors should be considered simultaneously as an effective selection criterion evolving high root yield genotypes of their direct positive contribution to root yield. This study suggests the higher value of residual effect (0.92) indicated more yield components should be considered in the future to account for the variation in cassava root yield.

Key Words: Cassava; Correlation, Direct effect; Manihot esculenta**,** Path coefficient;

1.0 INTRODUCTION

Cassava *(Manihot esculenta* Crantz) is one of the most important food security crop in many tropical countries. It is the source food energy for 200 millions people in Africa (Nweke and Enete, 1999). Cassava can produce reasonable yield under marginal conditions of climate and soils where the other crops cannot survive (Iglesias, 1997). Its high productivity per unit of land and labour, and ability to recover from disease and pest attack and reputations as a famine reserve make this crop basic component of the farming systems in many areas of Africa (Nweke and Enete, 1999). As a consequence, any improvement of the efficiency in selecting and identifying cassava genotypes for different agro- ecologies would have great potential in terms of human food. Cassava fresh root yield is the main ambition of cassava breeding program. It is a complex character and is the product of several contributing factors affecting root yield directly or indirectly. Apart from the direct selection for root yield, the purpose of root yield enhancement may in most situations, be effectively achieved on the basis of performance of root yield components and selection for closely related morpho-physiologcial characters (Kawano *et. al* 1998). Genotypic and phenotypic correlations are of value to indicate the degree to which various morpho-physiological characters are associated with productivity. Path coefficient analysis is a reliable statistical technique, which provides means to quantify the interrelationship of different yield and yield related and some other path ways to produce an effect (Kang 1994).

This technique, therefore, provides a significant assessment of specific factors producing a given correlation and can be successfully in use formulating a selection strategy. Since path-coefficient analysis was applied by

(Dewey and Lu (1959) on crested wheat grass, this method has been followed extensively to facilitate selection in various crops. Asfaw (2006) and Tewodros *et al*. (2008) reported root yield per plant was positively correlated with components and indicate whether the influence is directly reflected in the root yield or plant height, number of verticals/hill and weight of above ground plant parts in taro and aerial yam.

However, number of verticals/hill and plant height made the most important contribution. Amsalu (2003) reported number of verticals/hill root length and diameter were positively correlated with fresh root yield cassava plant whereas number of root and branches per plants had the greatest direct effect on cassava fresh root yield. Therefore, the present studies were initiated to investigate the interrelationship of yield related characters and extent of their contribution to fresh root yield on cassava. The information so derived could be exploited in devising further selection strategies and to develop new varieties of cassava capable of high productivity.

2.0 MATERIALS AND METHODS

2.1 Description of the Study Area

2.1.1 Description of the Study Area

The experiment was conducted at Jimma Agricultural Research Center located 366 km south west of Addis Ababa situated at latitude 7^o 46' N and longitude 36^o E having an altitude of 1753 m.a.s.l. The soil of the study area is Eutric Nitosole with a pH of 5.3 that receives mean annual rainfall of 1432 mm with maximum and minimum temperature of 29.2 ^{0} C and of 8.90 ^{0} C, in *2009/10 and 2010/11* growing seasons. These environmental conditions are conducive for production of cassava (Tewodros, 2012).

2.1.2 Experimental Materials and Design

Thirty five accessions of cassava (Table 1) were considered in this study. The accessions were collected from south and southwestern parts of Ethiopia, during the period 2002-2008 by Jimma Agricultural Research Center (JARC) and maintained at JARC. The collections covered diverse agro-ecologies with an altitude range of 1170-1940 m.a.s.l, representing one of the major cassava production areas in the country. The experiment was laid in RCBD with three replications on February 15, 2009 at a spaced 1m x 1m and provided all agronomic practices as needed for two consecutive years.

2.1.3 Data Collection

All the data were collected 18 months after planting as it have been suggested by Mulualem and Ayenew (in press). Accordingly, data on plant height(cm), number of main stem/plant, number of branch/plant, average canopy diameter/plant(m), average stem girth(cm), average number of roots/plant, average length of roots/plant(cm), average diameter of roots/plant(cm), root fresh weight (kg/plot), above ground biomass weight (kg/plant) and root dry weight (kg/plot) were recorded. Five plants were (400g each) randomly taken from the plot and were floured to get the dry matter yield of the product.

2.1.4 Statistical analysis:

The data of thirty five cassava accessions were analyzed according to the method suggested by Steel and Torrie (1984).In addition a method described by Kown and Torrie (1964) and Dewey and Lu (1959) was followed to calculate phenotypic and genotypic correlation coefficients, and path coefficient, by using SAS software statistical package (SAS, 9.1) and 0.05 level of significance and their correlation.

3.0 RESULTS AND DISCUSSION

The analysis of variance for fresh root yield and its components revealed highly significant differences ($p<0.01$) between accessions and year interaction which is the result of average number of roots/plant and average roots length/plant. Genotypic and phenotypic correlation coefficients provided a quantitative evaluation of effects of environments on particular character. Accordingly, the association of root yield with other yield related characters was estimated by genotypic and phenotypic correlation coefficients (Table 2).

Root fresh weight had a highly significant *(P=0.01)* positive phenotypic correlation with plant height, canopy diameter, stem girth, and root diameter. At genotypic level, Plant height was showed significant and positive correlation with canopy diameter, stem girth, root diameter, weight of above ground plant parts and root dry weight, this shows, the increments vegetative plant parts has significant effect on the dry matter yield of cassava. However, the majority of the characters in genotypic level had show a non-significant ($P > 0.05$) correlation. For example, there is no character that showed significant association with root fresh weight per plot although some of them have got higher degree of correlation with it. This may suggest that the phenotypic association of such characters with root fresh weight per plot is not genotypic inheritance but more of environmental influence.

Root diameter was significantly *(P=0.01)* and negatively correlated with number of vertical stem per plant. The genotypic correlation between the two characters is higher than its phenotypic correlation coefficient indicating that the association between them is genotypic inheritance but not environmental influence. So during selection one has to give due care to the size of root because the bigger tubers have provided low dry matter content.

In general, the nature of phenotypic and genotypic correlation coefficients either positive or negative was observed to be more or less similar in respect of the majority of the characters studied. It is of interest to note that the significant positive correlation coefficients estimated at genotypic level were also mostly found significant and positive at phenotypic level. Moreover, the significantly higher magnitudes of positive genotypic correlation than the corresponding phenotypic correlation in respect to some of the characters suggest that these characters were genetically controlled.

Path coefficient analysis (Table 3) at genotypic level revealed that root diameter had maximum direct positive effect on root fresh weight per hill ($p = 1.978$) followed by number of branches per plant ($p = 1.353$). However, as root diameter becomes higher, it has a negative impact on the number of roots produced per plant and the number of branches produced on the main stem which could be a cause for the high correlation coefficient that existed between tuber weight per plot and root diameter ($r_g = 0.78$). The same results ware observed with Asfaw and Weyesa (2006), and Tewodros (2008) in studies of *Collocasia esculenta*, *Plectranthus edulis* and *Dioscorea bulbifera.*

Hence, while undertaking selection for root fresh weight per plot in cassava, one has to consider these two yield components with higher number of roots that could result in low diameter tubers (Dwivedi, A.K. and H. Sen, 1999; Amsalu, 2003). On the other hand, plant height, number of vertical stem/plant, canopy diameter, length of roots/plant weight of above ground plant parts and root dry weight have negative direct effect on root fresh weight per plot (Amsalu, 2003). Though the direct effect of number of vertical stem/plant was negative ($p = -1.07$), its correlation coefficient was negative and relatively lower ($rg = 0.18$) as it has high positive indirect effect on tuber diameter and number of tubers per hill. Similarly, even if canopy diameter exerted the minimum negative direct effect ($p = -0.196$) on root fresh weigh per plot, its correlation with root dry weight was positive because of its high positive indirect effect on root length. However, Dwivedi, *et, al.* (1999), reported that canopy diameter showed positive direct effect on tuber fresh weight on *Collocasia esculenta* var. antiquorum ($p=0.153$).

With the same analogy, although root dry weight exerted negative direct effect on root fresh weight per plot and negative indirect effect on plant height and canopy diameter, the negative correlation coefficient between plant height and root fresh weight per plot. Similar positive direct effect of number of roots per plant was also reported on potato and cassava by Pandey *et al.* (2005) and Rubaihayo *et al.* (2001), respectively. The residual effect (h = 0.920) is relatively high indicating that the trait considered in this analysis failed to sufficiently explain the variation in cassava yield. This suggests that more yield components should be considered to account for the variation in cassava yield.

4.0 Conclusion

From the present studies, it may be concluded that plant height, canopy diameter and root diameter appeared to contribute to the root fresh weight. Therefore indirect selection for higher fresh root yield may be effective for improving these characters.

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Table 1. Description of the experimental materials used in the study

No	Genotype Name	Source	No	Genotype Name	Source
1	AAGT 108	Local collection	19	AAGT 192	Local collection
2	AAGT 191	Local collection	20	AAGT 095	Local collection
3	AAGT 134	Local collection	21	5648-50	Local collection
4	AAGT 189	Local collection	22	AAGT 101	Local collection
5	AAGT 150	Local collection	23	5538-19	Local collection
6	AAGT 160	Local collection	24	5632-8	Local collection
7	AAGT 156	Local collection	25	50298-21	Local collection
8	AAGT 201	Local collection	26	104/72 white	Local collection
9	AAGT 200	Local collection	27	Walomo	Local collection
10	AAGT 104	Local collection	28	AAGT 028	Local collection
11	44/72 NW	Local collection	29	AAGT 009	Local collection
12	55324-4	Local collection	30	AAGT 062	Local collection
13	5048-33	Local collection	31	AAGT 194	Local collection
14	104/72 red	Local collection	32	45/72 NW	Local collection
15	50583-14	Local collection	33	44/72 NR	Local collection
16	45/72 NR	Local collection	34	50254-12	Local collection
17	46330-22	Local collection	35	5028/73	Local collection
18	AAGT 049	Local collection			

Table 2. Genotypic (above diagonal) and Phenotype (below diagonal) Correlation coefficient among 11 traits in 35 Cassava accessions grown at Jimma

*Significant at 0.05 probability level; **= Highly significant at 0.01 level of probability level
PH= Plant height, NS= Number of vertical stem/plant, NB= Number of branches/plant, CD= Canopy diameter, GR= Stem girth, NoRo= number of roots/plant, LR= Length of root, DR= Diameter of roots, RFW= root fresh weight, WAGP= Weight of above plant biomass and RW= Root dry weight

Traits	RFW	PH	NS	NB	CD	GR	NoRo	LR	DR	WAGP	DW
RFW		0.30	-0.18	-0.24	0.12	0.54	0.01	0.27	0.78**	1.00**	1.00**
PH	1.00**		-0.68*	0.01	1.00**	1.00**	-0.59	0.09	1.00**	1.00**	1.00**
NS	-0.74**	-0.03		0.67*	-0.57	-0.48	0.69*	-0.52	--0.81**	-0.33	-1.00**
NB	-0.36	-0.04	0.38		0.44	-0.38	-0.24	0.04	-0.32	0.12	-0.69*
CD	1.00**	0.35	0.03	0.07		1.00**	-0.37	0.07	1.00**	1.00**	1.00**
GR	1.00**	0.31	-0.23	-0.17	-0.19		-0.14	0.92**	1.00**	1.00**	1.00**
NoRo	0.26	-0.12	0.12	-0.12	-0.49	0.35		0.08	-0.10	0.60*	-0.51
LR	0.43	0.31	-0.12	0.03	0.16	0.15	-0.04		0.21	0.31	-0.68*
DR	0.88**	0.35	-0.25	-0.15	0.12	0.55	-0.12	0.21		1.00**	1.00**
WAGP	0.33	0.42	-0.05	-0.07	0.15	0.34	0.01	0.39	0.27		-0.35
DW	0.44	0.39	-0.11	-0.08	0.35	0.21	-0.17	0.36	0.28	0.42	

Table 3. Genotypic direct (bold and underlined) and indirect effects of ten quantitative traits on root yield in Cassava

Traits	PH	NS	NB	CD	GR	NoRo	LR	DR	WAGP	RDW	rg
PH	**-1.826**	1.090	0.031	-0.498	0.026	-1.280	0.1981	1.419	-1.286	0.205	0.30
NS	1.252	**-1.047**	1274	0.112	-0.010	1.293	-1.082	-1.053	1.189	-0.027	-0.18
NB	-0.024	-2.039	**1.353**	-0.087	-0.008	-0.529	0.085	-1.605	1.154	0.010	-0.24
CD	-4.640	1.755	1.052	**-0.196**	0.076	-0.805	0.159	1.680	-1.112	0.586	0.12
GR	-1.120	1.483	-0.890	-0.666	**0.022**	-0.300	1.224	1.582	-1.831	0.290	0.54
NoRo	1.088	-1.118	-0.580	0.073	-0.003	**1.148**	0.173	-0.511	-0.831	0.050	0.01
LR	-0.173	1.286	0.096	-0.015	0.020	0.178	**-1.079**	1.082	-1.404	0.025	0.27
DR	-1.350	1.481	-0.758	-0.381	0.025	-0.220	0.452	**1.978**	-1.249	0.180	0.78
WAGP	-1.354	1.265	-0.845	-0.311	0.026	0.556	0.908	4.413	**-1.213**	0.219	1.00
RDW	-1.514	1.005	0.285	-1.279	0.078	1.291	0.642	1.171	-1.252	**-0.083**	1.00

Residual effect= 0.920
PH= Plant height, NS= Number of vertical stem/plant, NB= Number of branches/plant, CD= Canopy diameter, GR= Stem girth, NoRo= number of roots/plant, LR= Length of root, DR= Diameter of roots, RFW= root fresh weight, WAGP = Weight of above plant biomass and RDW= Root dry weight.