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Full Length Research Paper

Genetic relationships and selection indices for cassava root yield in Adamawa State, Nigeria

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Variation, correlations and path coefficient analysis were calculated for root yield among 19 improved cassava clones for two harvesting periods over two years of evaluation in a randomized complete block design with three replications. Root width and leaf length were significant at 6 months harvesting, but not at 9 months harvesting. Estimates of phenotypic, genotypic and environmental variance for both harvesting periods provided evidence for genetic improvement. Heritability was low for root length, meaning that environment had a strong influence in this phenotype. The path coefficient analysis for data set at 6 months harvesting indicated that leaf width recorded the largest direct effect on tuber yield; this was masked by the indirect influence through cassava anthracnose disease, plant height, root length, percent starch, petiole length and top weight. The incidence of cassava anthracnose disease manifest in a significant negative correlation coefficient with root yield. The large positive direct effect of tuber/plant was masked by the indirect influence of petiole length and top weight. The dry matter yield had a positive direct effect on yield, but this was indirectly lowered by cassava anthracnose disease incidence and percent starch. At 9 months harvesting, leaf width had the largest direct effect on tuber yield, this was masked largely by indirect influence of percent dry matter. This study summarized the influence of leaf width, leaf length and tuber/plant as important selection indices for root yield at 6 months. The path analyses for both sampling months demonstrated that leaf width, leaf length, and tuber/plot are important selection indices for root yield.

Key words: Harvest periods, tuber yield, cause and effect relationships, heritability, path analysis and cassava.

INTRODUCTION

Cassava *(Manihot esculenta* Crantz) is valued for its outstanding ecological adaptation. Reasonable root yield are obtained under marginal and optimal conditions. The increasing economic potential of cassava necessitated this research in Adamawa state, Nigeria. The state is characterized by high daily temperature (34℃) and low night temperature (-12℃). Variation exists in dura tion, distribution and intensity of rainfall, drought; besides most soils are of low soil fertility (Adebayo, 1999). In Adamawa state, cassava is produced in less than 30,000 ha (PCU, 2004). Farmers cultivate land races surrounded by fence made from sorghum/maize stalks (Adeniji and Odo, 2007). Preliminary evaluation of land races and improved cassava clones in Mubi and Mayobani (Adamawa state) indicated substantial variation for agronomic and root yield characters (Adeniji and Odo, 2007), which necessitated genetic studies and selection for this environment. At harvest (12 months after planting) most clones are lignified; besides, roots were destroyed by micro organisms, consequently, root yield is low. The desirability for early maturing and high root yielding genotypes among the farmers prompted the manipulation of harvesting time. The preference for early harvesting (6 and 9 months after planting) is high.

Genetic information on relationships and interdependence for root yield and other agronomic characters has been extensively researched elsewhere. The long standing opinion that cassava does poorly in the derived and Sahel savannah prompted this research in this environment. Correlation coefficients subject to path coefficient analysis have proven useful in providing information that describe a priori cause-effect-

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relationships such as yield and yield components (Miilligan et al., 1990). Also, important information is desirable for developing selection indices. The use of selection indices for developing selection criteria have been emphasized (Miller et. al., 1978). Several improved cassava clones have been released in the forest and savannah agro ecological zone but they show variation for agronomic characters, root yield and reaction to diseases (Raji et. al., 2007). Evaluation of these clones in the derived savannah could provide information on their adaptation and genetic potentials for yield and yield components. This study therefore seek to evaluate the magnitude of variation for agronomic and root yield characters at 6 and 9 months after planting and to predict determinants of root yield as well as developing a selection criteria for improving root yield through indirect yield components selection via selection index.

MATERIALS AND METHODS

Nineteen cassava (97/2205, 92/0057, 97/0234, 92/B/00061, 92/0326, 92/0326, 98/6510, 4(2)1425, 82/00068, 96/1632, 92/0067, 97/4763, TME 419, 95/0289, 97/0505, 92/0057, MP98/0068, TMS 30572, 98/0581) sourced from the germplasm collection of the International Institute of Tropical Agriculture, Nigeria (IITA) were used in this study. Clones were evaluated in 2005 and 2006 planting seasons at the Teaching and Research Farm, Adamawa State University located at Mayo Bani (Lon 13℄E, Lat. 10.1℄N, 879masl). Adamawa state is predominantly an agrarian state; its climatic conditions are hot and dry for most part of the years. The rainfall pattern is monomodal, which starts in June and ends in October each year. The soil analysis of the experimental area for both years of evaluation indicated a pH of 5.16% sand, 20.00% clay, 22.40% organic carbon, 0.68 organic matter content, 1.12 total nitrogen, 1.36 phosphorus, 1.35 total nitrogen, 0.112 phosphorus, 1.35 ppm potassium, 9.10 ppm sodium, 2.50 ppm carbon, 2.50 ppm magnesium, 0.60 ppm cation exchange capacity (CEC), 18.70 effective cation exchange capacity (ECEC), 20.50 C: N ratio 6.10 and base saturation 1.10. The experimental site was ploughed, harrowed and ridged. For both years of evaluation, a randomized complete block design with three replications was adopted. A total of 19 plots were allotted to each replication; each plot measured 25 m^2, having 25 stands/plot. Planting was done on the 2^{nd} and 10^{th} of July for 2005 and 2006 evaluation, respectively. Cassava clones measuring 15 cm long, containing approximately 12 nodes were planted in a slanting position at spacing of 1 by 1 m. Weeding and mounding-up were carried out simultaneously as deemed fit, fertilizer application of NPK 15:15:15 at 600 Kg ha^{-1} was done. At 6 and 9 months after planting, by randomly picking ten stands, five cassavas stands from each of the two middle rows, agronomic and root yield characters were measured. Plant height (cm) and height at branching (cm) was determined with a meter rule from the ground level to the top of the main stem and to the first branching point. Other characters measured include petiole length (cm), length and width of leaves (cm), stem girth (cm), canopy spread (cm), number of nodes, number of leaves, inter-node distance (cm) and height at primary branching (cm), root length (cm), root number/plant, root yield (kg).

Quantitative data collected for each year of evaluation (2005/2006 and 2006/2007) were summarized, pooled and subjected to combined analysis of variance using the Generalized linear model procedure of SAS (1999), to determine the magnitude of the main effects and their interactions. Means were separated using PROC DUNCAN procedure of SAS (1999). Variance components and broad sense heritability estimates were estimated as specified by Burton (1979). Correlation analysis among the characters was done using PROC CORR. Using root yield kg ha^{-1} as response variable; important characters associated with root yield kg ha-1 were determined by PROC REG procedure of SAS (1999). Using correlation matrix, characters that are positively correlated with tuber yield were selected and used to determine the direct and indirect causes of root yield kg ha^{-1} using the procedure of Dewey and Lu (1959). The percent dry matter was computed as a ratio of dry root weight to the fresh weight multiplied by 100. Percent starch was computed using the equation (IITA, 1993).

$$Y = 28082 + 0.8679X$$

Where, Y is the starch content and X is the dry matter percentage.

RESULTS AND DISCUSSION

Mean squares for agronomic and tuber yield characters at 6 and 9 months for both years of evaluation are shown in Tables 1 and 2. Significant differences ($P<0.01$) was recorded for plant height, cassava mosaic virus, cassava bacterial blight, cassava anthracnose disease, petiole length, internode distance, leaf width, stem girth, top weight, tuber yield/plant, tuber yield/plot, percent dry matter, dry matter yield, percent starch, canopy spread and number of leaves. Root width and leaf length were significant at 6 months sampling, but not at 9 months sampling. This means that at 6 months after planting, the accumulation of photosynthate in the roots was not uniform. Also the number of nodes/plant was statistically significant at 9 month sampling, but not significant at 6 month sampling. Significant differences as found for characters imply differential response among the cassava clones and the magnitude of inherent variation for these characters. Similar results has been reported for agronomic and root yield characters, when harvested at 12 months after planting (Aina et. al., 2007). Estimates of phenotypic variation were greater in magnitude than their corresponding genotypic and environmental variance for both sampling periods. This shows that an ample scope for genetic improvement for these characters is worthwhile. Heritability estimates was low for root length and leaf width, meaning that environmental factors had considerable influence on the phenotypic expression of these characters. This trend may be associated with the fact that both root length and leaf width is still under active physiological process.

The path coefficient analysis showed that at 6 months harvesting (Table 3), the leaf width recorded the largest direct effect on tuber yield. This was masked by the indirect influence through cassava anthracnose disease, plant height, root length, percentage starch, petiole length and top weight. However, the leaf width recorded a positive correlation coefficient with tuber yield. Implying that tuber yield at 6 months after planting and leaf width of the cassava leaves are important determinant of tuber

Table 1. Mean square for agronomic and root yield characters of cassava sampled at 6 months after planting during 2005/2006 and 2006/20007 seasons.

Parameter	Pht	Cmv	Cbb	Cad	Ptl	Indst	Rtw	Rtl	Lvsl	Lvsw	Stmgr	Topwt	Tub/pl	Tub/plot	Pdm	Dmy	Pstach	Cansp	Nolvs	Ht1br
Genotypes	1631.18**	0.65**	0.38**	1.96	85.75**	2.20**	18.94**	27.22	20.94**	0.10**	6.10**	0.26**	21.87***	0.97***	102.75***	511.07	83.79***	1890.16***	**2583.27*** **	**174.49**
Error	171.89	0.0000	0.03	0.000	18.30	0.23	0.43	47.72	1.92	0.21	0.36	0.003	1.30	0.001	1.26	20.31	0.96	424.40	1128.87	158.72
R2	0.83	100	0.85	100	0.70	0.82	0.39	0.71	0.85	0.96	0.89	0.98	0.89	0.99	0.98	0.97	0.98	0.70	0.53	
σp	658.32	0.02	0.02	0.06	97.95	2.35	19.23	59.03	22.22	0.21	6.34	0.26	22.74	0.32	103.59	1524.54	103.59	2173.09	2335.79	260.30
σg	486.43	0.02	0.0	0.06	79.65	2.12	18.79	11.31	20.30	0.03	5.98	0.26	21.44	o.32	102.	1504.23	102.83	1748.69	2206.96	121.58
Hb	74	100	100	100	81.0	90.2	98.0	19.0	91.0	14.29	94.32	100	94.00	100	99	99.0	99	80.0	95	43

**, Significant at 1%level of probability; *, significant at 5%level of probability; Hb, broad sense heritability; Plt Ht, plant height; Pet L, petiole length; Lvs L, leaf length; Lvs W, leaf width; Stm Gr, stem girth; Nodes,number of nodes; Nolvs, number of leaves; Int dst, Inter node distance; Ht 1^0 br, height at primary branching; Pltht, plant height; Cad, cassava anthracnose; CMV,cassava mosaic virus; CBB, cassava bacterial blight; Rtl, root length; Lvl, leaf length; Lvw, leaf width; Petl, petiole length; Topwt, top weight; Tub/plt,tuber/plant; Dmy, dry matter yield; Pstach, percent starch; Cansp, canopy spread;Tub/plot, tuber /plot; Rtl, rootlength; Rtw, root width.

Table 2. Mean squares for agronomic and root yield characters of cassava sampled at 9 months after planting during 2005/2006 and 2006/2007 seasons.

Parameter	Pht	Cmv	Cbb	Cad	Ptl	Indst	Rtw	Rtl	Lvsl	Lvsw	Stgt	Tpwt	Tubpl	Tubplot	Pdm	Dmy	Pst	Cansp	Nolvs	Htibr
Genotypes	22.92.23***	0.65***	0.56***	1.96***	45.27***	2.20***	20.03	126.56**	277.21	1.26	11.79***	0.45***	41.93**	0.43**	111.72	2211.56***	90.4***	1516.61**	21207.89**	946.42***
Error	193.54	0.00	0.03	0.00	2.58	0.34	19.94	27.22	254.33	0.05	1.47	0.004	1.14	0.17	1.28	28.39	0.91	270.51	530.92	51.61
R^2	0.85	100	0.86	100	0.82	0.82	0.38	0.71	0.39	0.93	0.81	0.98	0.94	0.57	0.98	0.98	0.98	0.74	0.95	0.91
σp	2421.36	0.02	0.16	0.06	46.99	2.36	32.65	144.71	446.76	1.29	12.77	0.04	42.71	0.05	112.57	2230.92	30.74	1696.99	21555.17	980.83
σg	2227.82	0.02	0.12	0.06	44.41	2.12	13.17	117.49	192.43	1.24	11.30	0.04	41.57	0.04	111.29	2201.93	29.83	1426.44	21034.25	929.22
Hb	0.92	100		100	0.95	0.51	0.42	0.82	0.43	0.96	0.88	100	0.97	0.80	0.99	0.99	0.97	0.84	0.98	0.95

**, Significant at 1%level of probability; *, significant at 5%level of probability; Hb,broad sense heritability; Plt Ht, plant height; Pet L, petiole length; Lvsl, leaf length; Lvsw, leaf width; Stm Gr, stem girth; Nodes, number of nodes; Nolvs,number of leaves; Int dst ,Inter node distance; Ht 1'br , height at primary branching; Pltht, plant height; Cad, cassava anthracnose; CMV, cassava mosaic virus; CBB, cassava bacterial blight; Rtl, root length; Lvl, leaf length; Lvw, leaf width; Petl, petiole length;Topwt, top weight; TUB/plt, tuber/plant' Dmy, dry matter yield; Pstach, percent starch; Cansp, canopy spread; Tub/plot, tuber /plot; Rtl, rootlength; Rtw, root width.

yield. The negative influence of cassava anthracnose yield in this environment, but its negative correlation coefficient with dry matter yield show that for high yielding tubers, the incidence of cassava anthracnose disease must be reduced. Leaf width and tuber/plant are important selection indices for root yield at 6 months after planting in this environment. At 9 months harvesting (Table 4), leaf width had the largest direct effect on tuber yield, its influence was masked largely by indirect length recorded the second largest negative direct effect on tuber yield/plot. The positive indirect influence through leaf width was masked by negative indirect influence of percent starch. However, a negative and statistically significant correlation coefficient between percent starch and tuber yield was recorded in the study. Furthermore, the number of tuber/plant recorded a large direct effect on tuber yield after leaf width; itsexpression of percent dry matter and enhanced by percent starch. The path analysis for both sampling months demonstrated that leaf width, leaf length, and tuber/plot are important selection indices for root yield. The negative association between dry matter yield, percent starch and root yield suggest a selection compromise.

Table 3. Direct and indirect effects of characters to tuber yield in cassava at 6 month harvesting for 2005/2006 and 2006/2007 seasons.

Parameter	Direct effect	Pltht	Cad	Rtl	Lvl	Lvw	Petl	Topwt	Tub/plt	Dmy	Pstach	Correlation coefficient
Pltht												0.36
Cad	-4.00	0.78		0.35	3.97	-0.08	-0.36	-1.33	3.88	-2.19	-1.53	-0.72
Rtl	-1.85	-0.06	0.41		-0.55	0.46	-1.67	-1.27	3.73	-1.06	2.15	0.49
Lvl	4.58	-1.16	-2.23	-1.39		1.90	-0.87	-0.57	0.28	1.41	-1.48	0.47
Lvw	4.00	-1.06	-0.07	-0.11	0.72		-0.34	-0.83	0.62	1.05	-3.46	0.52
Petl	1.62	-0.29	0.006	-0.99	0.21	0.004		1.21	-0.69	0.20	-0.74	0.54
Topwt	2.01	-0.25	-0.04	-0.95	-0.03	-0.44	0.96		-0.74	0.42	-0.48	0.54
Tub/plt	2.24	-0.24	0.38	0.26	1.21	1.23	-1.60	-1.11		1.06	-2.89	0.54
Dmy	-11.57	0.43	-8.49	-1.51	2.31	0.35	9.87	0.21	0.18		-6.37	-0.45
pstach	-9.16	7.31	-0.17	4.81	-0.19	-0.86	-0.09	-1.19	-0.18	-0.02		0.32

Pltth, Plant height; Cad, cassava anthracnose; Rtl, root length; Lvl, leaf lebgth; Lvw, leaf width; Petl, petiole length; Topwt, top weight; Tub/plt, tuber/plant; Dmy, dry matter yield; Pstach, percent starch.

Table 4. Direct and indirect effects of characters to tuber yield in cassava at 9 month harvesting for 2005/2006 and 2006/2007 seasons.

Parameter	Direct effect	Lvl	Stmgr	Pdm	Pstch	Tub/plt	Pltht	Petl	Correlation coefficient
Lvl	7.72		-1.56	-9.50	3.20	1.00	0.12	-0.13	0.85**
Stmgr	-4.81	-0.64		14.90	-22.77	13.07	-3.97	4.00	0.38**
Pdm	3.37	-2.10	-16.40		0.02	16.20	0.07	0.01	0.90**
Pstch	0.71	-0.43	-0.17	0.07		0.12	-0.13	-0.11	-0.45**
Tub/plt	4.03	0.23	-0.14	-4.06	4.31		0.13	-3.60	0.92**
Pltht	-2.27	-0.32	0.80	6.65	-7.56	-9.59		13.52	0.73**
Petl	-6.87	7.43	3.90	2.08	-4.20	-1.23	-0.87		0.24

Pltth, Plant height; Lvl, leaf lebgth; Petl, petiole length; Tub/plt, tuber/plant; Stmgr, stem girth; Pstach, percent starch; Pdm, percent dry matter.

REFERENCES

Adebayo Tukur (1999). Adamawa State in the maps Paraclete Publishers, p. 111.

Adeniji OT, Odo PE (2007). Preliminary evaluation of cassava yield and yield components among cassava clones grown in Adamawa state, Nigeria. Proceedings of the 31st Annual Conference of the Genetic Society of Nigeria 5th - 9th November, p. 2006

SAS institute (1999) SAS Users guide: Statistics. SAS institute, Cary NC, 584pp

Dewey DR, Lu KH (1959). A correlation and path coefficient analysis of components of crested wheatgrass seed production. Agron. J., 51: 515-518.

Raji AA, Ladeinde TAO, Dixon AGO (2007). Agronomic traits and tuber quality attributes of farmers growncassva landraces. J. Trop. Agric., 45(1-2): 9-13.

PCU (2004). Project Coordinating Unit, Federal Ministry of Agriculture, Newsletter Vol 3. Abuja, Nigeria.

(Miller JE, James NI, Lyrene PM (1978). Selection indices in sugarcane Crop Sci., 83: 369-372.

IITA (2001). Cassava IITA/Crops. Web://www.iita.org/crop/cassava htm

Milligan SB, Gravois KA,.Bischoff KP, Martin FA (1990). Crop effects on genetic relationship among sugarcane traits. Crop Sci., 40: 927-931.