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Stability of yield and selected yield components of cashew (*Anacardium occidentale* L.) in Southern and Eastern Tanzania

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Abstract

Studies were undertaken to evaluate G x E interaction and determine stability of elite cashew hybrids and thereby identify widely and/or specifically adapted hybrids in the Southern and Eastern Tanzania. Results showed significant hybrid x locations interaction for all variables indicating differential genotypic responses of yield and yield components across the tested environments. High yielding genotypes with broad adaptation and some with specific adaptation were identified. Of these H3, H5, H6, H15, H16, H22, H23, H24, H26, H27 and H29 were adapted to the varying environments. In the contrary, high yielding unstable hybrids H2, H4, H7, H18, H19, H25 and H30 were more suitable for Nachingwea site while H1, H8, H10, H11, H13 and H17 were more favourable for Chambezi site. Hybrids H22, H5 and H24 were identified as the best in stability and yield with good agronomic attributes, and tolerance to cashew leaf and nut blight disease. Among the least stable hybrids in yield, H4, H8, H17, H11, H18 and H30 registered high yields with good agronomic traits. H28, H12 and H9 appeared to be stable but recorded low yields. Therefore, crosses between these two groups will likely combine stability and yield so as to have stable cashew hybrids with high yield. Chambezi site with higher cashew leaf and nut blight disease due to more humid and warmer conditions had fewer productive flowers, higher individual kernel weights, fewer nuts per tree but lower total yields.

Keywords: Cashew, Hybrid, Location, Stability, Yield.

Introduction

Cashew (*Anacardium occidentale* L.) is the main cash crop and the leading source of income for more than 300,000 households in Southern and Eastern Tanzania[1]. Cashew is commercial cultivated in most areas of an altitude of 0-700 m above sea level, although it can also grow over 1000 m above sea level[2]. Previously it was known to be grown mainly along the coastal area in Tanzania but currently grown even inlands. Due to its adaptive ability in a wide range of agro climatic conditions and the increase in its economic importance, some non-traditional cashew growing areas (such as Iringa, Mbeya, Singida, Dodoma, Morogoro, Mbarali, Mbinga and Songea) have started planting cashew trees[3]. Cashew is sensitive to the type of growing environments in particular high rainfalls with low temperatures and should therefore be grown in suitable agro-ecological areas for good performance[4].

Performance of a particular genotype is a result of its genetic makeup and the environment in which it has been grown[5]. In practice often the same cultivar may not exhibit the same phenotypic performance under different environments. When the G x E interaction is not regarded, a superior genotype in one environment can be considered superior in other environment whereas presence of G x E interaction confirms particular genotypes being superior in particular environments[6].

Yield stability of a genotype across different environments is very crucial for variety recommendation[7]. The genotype should posses the genetic trait of superior performance under normal growing conditions, and is supposed to give acceptable production under less favorable environments[7]. Stable performance of a particular genotype across a wide range of environmental conditions is generally considered desirable[8]. There are different methods that are used in determination of stability which include genotypic variance, coefficient of variation, ecovalence, stability variance, regression coefficient and deviations from regression. Ecovalence method is known to be the simplest method, based on the dynamic concept of stability.

It was proposed by Wricke[9], who defines the term ecovalence as the contribution of each genotype in all environments, to the sum of squares of the G x E interaction. If ecovalence is small, agronomic stability is high. Before the new varieties are proposed for release, information on genotype and environment interactions and stability whether they are specific or widely adapted should be made available to the user[10].

The objective of this study was to identify high yielding cashew hybrids adaptable to different agro ecological conditions, with prospects for incorporating them into breeding programmes or multiplication and distribution of planting materials.

Materials and methods

The experiment was undertaken during the 2014/2015 cropping season in the Southern (Nachingwea) and Eastern (Chambezi) zones of Tanzania. Nachingwea is located at 10°20'S, 38°46'E, altitude 465 m; and Chambezi at 6°31'S, 38°55'E and altitude 33m above sea level. Soil characteristics vary across locations. Nachingwea has clay soil with pH 5.5 whereas Chambezi has sandy loam with pH 6.6. Twenty nine developed cashew hybrids planted in 2005 (H1, H2, H3, H4, H5, H6, H7, H8, H9, H10, H11, H12, H13, H14, H15, H16, H17, H18, H19, H21, H22, H23, H24, H25, H26, H27, H28, H29 and H30) and a certified variety (AC4) were used in this study.

The design of the experiment was Randomized Complete Block Design (RCBD) with three replicates. The plot size was four trees planted in a row and spaced 12 m between trees and 12 m between rows. The trial was established in 2005/06 cropping season. Data collected were nut weight (NTWT), kernel weight (KNWT), nuts per panicle (NTPCL), nuts per tree (NTPT), percentage out turn (%OT) and nut yield (YLD).

The scores for the cashew leaf and nut blight disease were also recorded. Data were analysed using Genstat statistical package 16th edition so as to determine the interaction of genotypes with different sites. Data were also subjected to Agrobase program using Wi-ecovalence to determine stability analysis.

Results and discussion

Table-1 presents analysis of variance for the hybrids, locations and the interaction of hybrids and locations for yield, nut weight, nuts per tree, nuts per panicle, kernel weight, percentage out turn and blight disease. The results showed hybrids, locations and hybrid x locations interaction to display significant effects for all variables understudy.

The ranking of the means for yield and its components for the hybrids in combined analysis is presented in Table-2. It was evident that the control variety AC4 performed better in nut weight and kernel weight, however; AC4 did not differ significantly from 17 hybrids in nut weight and 11 hybrids in kernel weight.

Results further revealed that Nachingwea site outperformed Chambezi site in yield, nuts per tree and nuts per panicle. On the other hand, Chambezi excelled Nachingwea in nut weight, kernel weight and percentage out turn. Chambezi had higher mean cashew leaf and nut blight disease compared to Nachingwea (Table-3).

Weather conditions during the cropping season at Nachingwea and Chambezi sites are presented in Table-4. The total annual rainfall at Chambezi during the entire growing period was 1730.2 mm while at Nachingwea it was only 1043.3 mm.

The observations from the study on stability (Table-5) revealed that, there were variations in stability of the hybrid traits as most of them were stable in one or more traits but unstable in other traits. In Wi-ecovalence the agronomic trait is considered stable once the lowest Wi is recorded. The stability analysis on yield revealed that, nine hybrids were more stable across the locations as they recorded low Wi values. These were H3, H23, H22, H28, H6, H5, H12, H9 and H24. Among these hybrids H5, H6, H22, H24, H3 and H23 recorded higher yields. On the other hand, hybrids H4, H14, H8, H17 and H11 were considered least stable as they had the highest Wi values. Adugna[11] pointed out yield stability as one of the hindrance the plant breeders face during development of broad adapted varieties with superior yield.

Table-1: Analysis of variance for yield, selected yield components and blight disease of cashew hybrids in combined analysis.

Source of variation	Mean square ANOVA values							
	DF	YLD	NTWT	NTPCL	NTPT	KNWT	%OT	CLNBD
Rep	2	26.29	0.44	1.33	198802	0.03	6.30	2819.1***
Hybrid	29	35.77***	3.53***	6.51***	1197035***	0.25***	8.14***	569.1***
Location	1	1053.49***	16.26***	2.93*	26623060***	1.99***	14.45*	25353.2***
Location*Hybrid	29	41.83***	1.51***	2.14***	988378***	0.11***	4.44**	517.4***
Error	118	13.29	0.42	0.78	250626	0.03	2.21	175.4
Total	179							

Key: DF = Degrees of freedom, YLD = Yield (kg/tree), NTWT = Nut weight (g), NTPCL =Nuts per panicle, NTPT = Nuts per tree, KNWT = Kernel weight (g), %OT = Percentage out turn, CLNBD = Cashew leaf and nut blight diseases. * Significant at $P \leq 0.05$, ** significant at $P \leq 0.01$, *** significant at $P \leq 0.001$.

Table-2: Ranked order of means for yield, selected yield components and blight disease of cashew hybrids in combined sites (Nachingwea and Chambezi).

Hybrid	YLD (kg/tree)	NTWT(g)	NTPT	NTPCL	KNWT(g)	%OT	CLNBD (%)
H1	17.72^{ab} (10)	7.73^{cdefgh}(22)	2335^{abc}(9)	4.83^{bcde}(9)	2.16^{defgh}(24)	28.03^{abcd}(21)	39.35^{abcd}(17)
H2	15.84^{b}(21)	7.06^{gh}(29)	2512^{abc}(5)	4.0^{cde}(17)	2.14^{defgh}(25)	30.27^{ab}(2)	55.56^{ab}(2)
H3	15.64^{b} (23)	$7.90^{bcdefgh}$(19)	2037^{bc}(18)	3.66^{de}(23)	$2.29^{bcdefgh}$(18)	29.19^{abc}(8)	49.42^{abcd}(6)
H4	17.65^{ab}(11)	$8.43^{abcdefg}$(11)	2131^{bc}(15)	3.33^{de}(28)	2.33^{bcdefg}(14)	28.29^{abcd}(19)	42.59^{abcd}(11)
H5	21.34^{ab}(2)	7.81^{cdefgh}(20)	2873^{ab}(3)	3.5^{de}(25)	2.25^{cdefgh}(20)	28.98^{abc}(10)	24.89^{cd}(28)
H6	18.45^{ab}(8)	$8.32^{abcdefg}$(15)	2203^{bc}(11)	3.5^{de}(26)	$2.32^{bcdefgh}$(17)	28.01^{abcd}(22)	31.02^{abcd}(22)
H7	15.40^{b}(24)	7.72^{cdefgh}(23)	1998^{bc}(19)	3.83^{de}(20)	2.32^{bcdefg}(15)	30.16^{abc}(3)	38.54^{abcd}(18)
H8	16.39^{ab}(17)	9.05^{abcd}(6)	1846^{bc}(25)	3.5^{de}(27)	2.52^{abcd}(5)	27.81^{abcd}(24)	29.51^{abcd}(24)
H9	14.57^{b}(26)	9.13^{abc}(5)	1616^{c}(28)	3.33^{de}(29)	2.49^{abcdef}(7)	27.36^{bcd}(27)	36.46^{abcd}(20)
H10	16.33^{ab}(18)	7.66^{defgh}(24)	2166^{bc}(13)	3.66^{de}(21)	2.12^{fgh}(28)	27.74^{abcd}(25)	51.04^{abc}(4)
H11	19.54^{ab}(5)	$8.39^{abcdefg}$(13)	2382^{abc}(7)	3.16^{e}(30)	2.45^{abcdef}(11)	28.47^{abc}(15)	40.62^{abcd}(14)
H12	14.18^{b}(28)	7.54^{efgh}(25)	1889^{bc}(24)	5.0^{bcde}(7)	2.13^{efgh}(27)	28.43^{abcd}(17)	39.81^{abcd}(15)
H13	17.64^{ab}(12)	$8.19^{abcdefg}$(17)	2156^{bc}(14)	4.0^{cde}(15)	2.23^{cdefgh}(22)	27.33^{bcd}(28)	47.77^{abcd}(7)
H14	14.09^{b}(29)	9.32^{ab}(4)	1479^{c}(30)	5.83^{abc}(4)	2.32^{bcdefg}(16)	25.16^{d}(30)	49.65^{abcd}(5)
H15	20.48^{ab}(4)	$8.41^{abcdefg}$(12)	2485^{abc}(6)	3.83^{de}(18)	2.35^{bcdefg}(13)	28.09^{abcd}(20)	44.44^{abcd}(9)
H16	16.71^{ab}(16)	8.71^{abcdef}(9)	1925^{bc}(22)	3.66^{de}(22)	2.47^{abcdef}(10)	28.51^{abc}(14)	37.50^{abcd}(19)
H17	17.25^{ab}(14)	8.78^{abcde}(8)	2044^{bc}(17)	6.66^{ab}(2)	2.49^{abcdef}(8)	28.34^{abcd}(18)	28.70^{bcd}(26)
H18	15.92^{b}(20)	7.44^{efgh}(26)	2124^{bc}(16)	3.83^{de}(19)	2.13^{defgh}(26)	28.69^{abc}(13)	52.55^{abc}(3)
H19	16.83^{ab}(15)	9.59^{a}(1)	1715^{c}(26)	4.0^{cde}(16)	2.75^{a}(2)	28.72^{abc}(12)	43.87^{abcd}(10)
AC4	15.36^{b}(25)	9.49^{a}(2)	1645^{c}(27)	5.16^{abcd}(5)	2.76^{a}(1)	28.86^{abc}(11)	39.58^{abcd}(16)
H21	14.24^{b}(27)	7.27^{fgh}(28)	1976^{bc}(20)	4.5^{cde}(11)	2.01^{gh}(29)	27.83^{abcd}(23)	58.10^{a}(1)
H22	19.0^{ab}(6)	$8.33^{abcdefg}$(14)	2370^{abc}(8)	4.5^{cde}(12)	2.24^{cdefgh}(21)	26.95^{cd}(29)	23.27^{cd}(29)
H23	16.06^{ab}(19)	$8.16^{abcdefg}$(18)	2170^{bc}(12)	6.66^{ab}(3)	2.51^{abcde}(6)	30.68^{a}(1)	40.97^{abcd}(13)
H24	18.08^{ab}(9)	8.71^{abcdef}(10)	2265^{abc}(10)	3.5^{de}(24)	2.59^{abc}(4)	30.13^{abc}(5)	29.17^{abcd}(25)
H25	15.68^{b}(22)	$8.22^{abcdefg}$(16)	1944^{bc}(21)	5.0^{bcde}(8)	2.48^{abcdef}(9)	30.14^{abc}(4)	30.55^{abcd}(23)
H26	24.09^{a}(1)	7.31^{fgh}(27)	3319^{a}(2)	4.33^{cde}(13)	2.18^{defgh}(23)	29.79^{abc}(6)	45.14^{abcd}(8)
H27	18.90^{ab}(7)	7.78^{cdefgh}(21)	2572^{abc}(4)	4.33^{cde}(14)	$2.27^{bcdefgh}$(19)	29.07^{abc}(9)	28.12^{bcd}(27)
H28	13.29^{b}(30)	8.80^{abcde}(7)	1586^{c}(29)	4.83^{bcde}(10)	2.41^{abcdef}(12)	27.63^{abcd}(26)	42.59^{abcd}(12)
H29	21.10^{ab}(3)	6.53^{h}(30)	3351^{a}(1)	7.0^{a}(1)	1.93^{h}(30)	29.70^{abc}(7)	31.71^{abcd}(21)
H30	17.34^{ab}(13)	9.38^{a}(3)	1909^{bc}(23)	5.16^{abcd}(6)	2.65^{ab}(3)	28.43^{abcd}(16)	21.53^{d}(30)
Mean	17.17	8.24	2167.47	4.40	2.35	28.56	39.13
SE±	3.64	0.64	500.62	0.88	0.17	1.48	13.24
%CV	21.2	7.9	23.1	20.1	7.5	5.2	33.8

Means with the same superscript letter(s) in the same column are not significantly different ($P \leq 0.05$) following separation by Tukey's Test. Key: YLD = Yield (kg/tree), NTWT = Nut weight (g), NTPCL =Nuts per panicle, NTPT = Nuts per tree, KNWT = Kernel weight (g), %OT = Percentage out turn, CLNBD = Cashew leaf and nut blight diseases. Numbers in parentheses indicate hybrid ranking.

Table-3: Location effects for yield, selected yield components and blight disease.

Location	YLD(kg/tree)	NTWT(g)	NTPT	NTPCL	KNWT(g)	%OT	CLNBD
Nachingwea	19.59	7.94	2552.05	4.53	2.24	28.28	27.27
Chambezi	14.75	8.54	1782.88	4.27	2.45	28.84	51.0
Mean	17.17	8.24	2167.46	4.40	2.35	28.56	39.13
SE_x (±)	0.38	0.06	52.77	0.09	0.01	0.15	1.39
$LSD_{0.05}$ (±)	1.07	0.19	147.78	0.26	0.05	0.43	3.91
P-value	0.001	0.001	0.001	0.05	0.001	0.05	0.001

Table-4: Annual rainfall and temperature for Nachingwea and Chambezi sites in 2014.

Month	Rainfall (mm)		Mean monthly temperature (°C)	
	Nachingwea	Chambezi	Nachingwea	Chambezi
Jan-14	179.6	0.2	26.52	29.33
Feb-14	275.9	107.7	25.92	28.75
Mar-14	227.2	228.2	25.7	28.33
Apr-14	173.9	254	25.32	27.7
May-14	61.4	405	23.78	26.46
Jun-14	0	19.4	23.08	26.51
Jul-14	0	44	22.78	26.09
Aug-14	0	37.6	23.81	26.08
Sep-14	0	71.4	24.4	25.73
Oct-14	12.3	54.2	26.49	27.14
Nov-14	2.3	254.8	27.76	27.34
Dec-14	110.7	253.9	27.74	27.98
Total	1043.3	1730.2	25.27	27.28

With respect to nut weight, hybrids H6, H8 and H16 appeared to be most stable due to their very low Wi (0.00) values. On this variable a number of hybrids were relatively stable as they had lowest Wi values.

When considering the number of nuts per tree hybrids H2, H27, H19, H1 and H5 had the least Wi values and they ranked top on nuts per tree. Therefore, they are considered as the most stable genotypes in terms of nuts per tree. A number of hybrids on the other hand had high values of ecovalence, this included H23, H24, H15, H17, H26, H29, H8, H30, H7, H4 and H3 hence were considered unstable. The results of stability for nuts per panicle showed a number of hybrids to be stable viz. H11, H16, H19, H4, H2, H12, H22, H28, H18, H21, H8, H24, H1, H26, H10, H13, H27, H5, H9, H25 and H30 as they had lowest ecovalence values.

Table-5: Wricke's ecovalence (Wi) stability for yield and selected yield components of cashew hybrids at two locations (Nachingwea and Chambezi).

AGROBASE: GXE - Wi - Ecovalence												
	YIELD		NUTWT		NTPCL		NTPT		KNWT		OT%	
Geno-type	GXE Statistic	Rank	GXE Statistic	Rank	GXE Statistic	Rank	GXE Statistic	Rank	GXE Statistic	Rank	GXE Statistic	Rank
H1	6.665	14	0.58	22	0.101	13	2.199	4	0.017	15	2.447	23
H2	6.122	13	1.80	30	0.020	5	0.117	1	0.149	29	0.657	14
H3	0.031	1	0.38	21	1.185	24	182.462	20	0.020	17	2.004	20
H4	48.305	30	0.04	7	0.008	4	208.141	21	0.018	16	1.419	17
H5	1.064	6	0.26	18	0.378	19	9.693	5	0.005	10	2.420	22
H6	0.954	5	0.00	2	1.329	26	53.737	14	0.000	1	0.155	9
H7	6.841	15	0.13	13	1.329	27	208.427	22	0.020	18	0.671	15
H8	23.674	28	0.00	3	0.068	11	211.090	24	0.006	11	2.200	21
H9	2.955	8	0.01	4	0.720	20	23.715	9	0.002	5	0.009	3
H10	9.121	17	0.19	15	0.146	16	44.152	12	0.009	13	4.917	30
H11	19.914	26	0.05	9	0.001	1	59.046	15	0.050	23	0.813	16
H12	1.396	7	1.06	27	0.020	6	11.201	6	0.042	22	1.434	18
H13	5.059	12	0.29	19	0.146	17	91.166	19	0.000	3	2.981	25
H14	30.350	29	0.89	25	2.419	30	59.875	16	0.078	24	0.288	12
H15	13.881	22	0.23	16	1.621	28	284.006	28	0.002	6	3.821	27
H16	16.411	23	0.00	1	0.001	2	44.302	13	0.025	19	4.544	28
H17	22.452	27	0.34	20	1.621	29	277.136	27	0.004	8	2.479	24
H18	18.782	25	0.04	6	0.045	9	66.736	17	0.004	9	0.000	1
H19	12.797	21	0.25	17	0.001	3	1.830	3	0.032	20	0.576	13
AC4	8.816	16	0.95	26	0.106	14	38.518	11	0.151	30	0.229	10
H21	4.593	11	0.85	24	0.045	10	15.585	7	0.097	26	0.012	4
H22	0.491	3	0.08	11	0.020	7	34.304	10	0.011	14	0.143	8
H23	0.121	2	0.03	5	1.185	25	378.043	30	0.033	21	0.274	11
H24	3.331	9	0.13	12	0.068	12	337.039	29	0.000	2	4.554	29
H25	12.595	20	0.06	10	0.845	21	71.127	18	0.009	12	0.048	6
H26	9.640	18	0.75	23	0.106	15	214.804	26	0.085	25	0.036	5
H27	4.467	10	1.62	29	0.199	18	0.503	2	0.138	28	0.128	7
H28	0.479	4	0.17	14	0.020	8	17.129	8	0.003	7	3.519	26
H29	9.684	19	1.11	28	1.066	23	211.706	25	0.104	27	0.000	2
H30	18.295	24	0.05	8	0.938	22	208.631	23	0.000	4	1.607	19

Key: NUTWT=Nut weight, NTPCL=Nuts per panicle, NTPT=Nuts per tree, KNWT=Kernel weight, %OT=Percentage out turn.

With respect to kernel weight, it is interesting to note that all hybrids could be considered stable as they had the least Wi values. Of these, hybrids H6, H13 H24 and H30 were the most stable as they recorded 0.00 Wi values and ranked 1st, 2nd, 3rd and 4th respectively in kernel weight.

Results from stability analysis for percentage out turn revealed that, fifteen genotypes namely H18, H29, H9, H21, H26, H25, H27, H22, H6, H23, H14, H19, H2, H7 and H11 showed adaptation to a wide range of environmental conditions as they had low ecovalence values. This suggests that, these genotypes were stable on percentage out turn.

Genotypes x Environmental interactions were highly significant for all the studied agronomic variables indicating differential genotypic responses of yield and yield components across environments. The six traits tested showed significant location effects implying that locations can be identified for cashew production.

Results from this study showed variations on cashew yield among hybrids within and across locations. Eleven hybrids namely H5, H6, H15, H16, H22, H23, H24, H26, H27, H3 and H29 were identified as the best as they excelled across locations. Seven hybrids namely H2, H4, H7, H18, H19, H25 and H30 excelled at Nachingwea which imply these hybrids were site specific thus favorable to Nachingwea. On the other hand, six hybrids namely H1, H8, H10, H11, H13 and H17 appeared to be better in yield at Chambezi site implying that, these hybrids can be grown for production at this site or areas with similar climatic conditions. Among the hybrids studied there were variations in stability in relation to yield and other quality attributes. Among the least stable hybrids in yield, H4, H8, H17, H11, H18 and H30 registered high yields with good agronomic traits. On the other hand, H28, H12 and H9 appeared to be stable but recorded low yields. Therefore, crosses between these two groups will likely combine stability and yield so as to have cashew hybrids with high yield and stable and these hybrids be considered in selection for yield improvement. According to Cvarkovic[12] study on maize, the high yield performance of the hybrid rely on genetic potential, realized in breeding program while the yield stability depends on the ability of the hybrid to confront limiting environmental conditions.

The overall mean yield at Nachingwea was higher as compared to Chambezi, with 19.59 kg/tree and 14.75 kg/tree respectively. Probably the low performance at Chambezi may be attributed to the fact that Chambezi is depleted soils. Nutrient depletion in soils greatly affects the quality of the soils which in turn soil's capacity to retain water and nutrients diminish which adversely reduce crop yield[13]. The weather conditions that prevailed during the cropping season 2014/2015 (Table-4), might have favored cashew leaf and nut blight disease development at Chambezi. These results agree with previous study by NARI[14] , which reported that, cashew leaf and nut blight disease develops under warm and humid conditions and is most active during wet weather especially after off season rains. However, hybrids H26, H11, H15 and H1 recorded higher yields at Chambezi despite of the fact that they had higher disease (blight) score and these could be considered tolerant to the disease.

Twenty-four hybrids had low ecovalence thus appeared to be stable based on nut weight. This agrees with the study by Aliyu[15] who observed nut weight as the most stable trait in cashew. Hybrids with low ecovalence have smaller fluctuations across environments and therefore are stable. Chambezi had higher nut weight compared to Nachingwea. High nut weight at Chambezi was probably due to availability of high moisture in the soil (Table-4), which might have favoured vegetative growth that increased surface area for photosynthetic activities and more photosynthetic products directed to seed formation. Chambezi site is a better site for nut weight compared to Nachingwea as a number of hybrids at Chambezi performed better than at Nachingwea. Aliyu[15] studying on phenotypic stability of yield components of cashew observed bigger nuts and less production in locations with high humidity which could have been attributed to high humidity and pest infestation. Chambezi site had high humidity and blight disease incidence than Nachingwea, and this could have contributed to less yield. High humid conditions have been attributed to severe fruit drop and low fruit retention in mango[16].

The mean kernel weight at Chambezi was much higher compared to Nachingwea probably, due to availability of moisture in the soil resulting from frequent rain showers influenced by the sea. Chambezi site with higher precipitation, humidity, conducive temperature that favoured cashew leaf and nut blight disease resulted to fewer productive flowers, fewer nuts per tree, higher individual kernel weights but lower total yields. The higher precipitations experienced during the season could have favoured vegetative growth that led to increased surface area for photosynthetic activities and more photosynthetic products directed to seed formation resulting to higher kernel weight. The kernel weight which ranged from 1.71g at Nachingwea to 2.86g at Chambezi was within the range reported by Blaikie[17] of 1.4 g to 3.2 g. As well as yield, cashew economic value is determined by the characteristics of kernel. Kernel weight is influenced by nut size and kernel recovery, the latter being the proportion (%) by weight of the kernel in the whole nut. On the other hand, the percentage out turn ranged between 24.50% and 31.87%. This is comparable with results obtained by Blaikie[17] who reported the range of 26% to 34%. However, these results were higher than the minimum standard (20%) acceptable by cashew processors in Tanzania[14]. Thus the accessions are within the accepted standards on this variable.

Conclusion

High yielding hybrids that are widely adapted and some with specific adaptation were identified. Hybrids H5, H6, H22 and H24 were observed to be very stable in yield, nut weight, nuts per panicle and kernel weight and at the same time they were high yielding genotypes, therefore they can be used in the multiplication and distribution as planting materials and breeding programs. Intercrosses between the stable, low yielding and good quality attributes hybrids (H28, H12 and H9) with the good quality, unstable and high yielding hybrids (H4, H8, H17, H11, H18 and H30) should be undertaken so as to have cashew progenies with high yield, good quality and stable attributes.

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