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Evaluation of local maize (*Zea mays* L.) varieties from Burkina Faso as source of tolerance to drought

G. Olaoye[1], A. Menkir[2♣], S.O. Ajala[2] and S. Jacob[2]

[1] Department of Agronomy, University of Ilorin, PMB 1515, Ilorin, Nigeria.
[2] International Institute of Tropical Agriculture, Oyo Road, PMB 5320, Ibadan, Nigeria or c/o L.W. Lambourn and Co., Carolyn House, 26 Dingwali Road, Croydon CR9 33 EE, UK

♣**Corresponding author e-mail**: a.menkir@cgiar.org

ABSTRACT

Objective: To evaluate local maize varieties from Burkina Faso under moisture deficiency to identify suitable genotypes to serve as sources of drought tolerance alleles for incorporation into improved cultivars.

Methodology and results: Fourteen local maize varieties from Burkina Faso and a hybrid check were evaluated under well-watered condition and drought stress imposed by withdrawing irrigation from 23 days before 50% anthesis until harvest at Ikenne in Nigeria in 1999 and 2000. Moisture deficiency significantly ($P<0.05$) reduced the number of ears per plant by 22% and grain yield by 53%. Three local varieties (Bondokuy-1, Dogona-1 and Douana-1) had grain yields that were either comparable to or higher than that of the hybrid check under moisture deficit. Relative ranking of genotypes for grain yield under well-watered condition was different from those under moisture deficiency. Two major clusters were formed for genotypes tested under each irrigation treatment, with entries in cluster 2 combining high grain yield with shorter anthesis-silking interval and lower leaf senescence rating. Some local varieties exhibited comparable performance to the hybrid check, suggesting the possibility that genes for high grain yield and other desirable agronomic attributes may have been introgressed into the local maize varieties through pollen transfer from adjacent improved varieties that have been cultivated in the region and thus increasing their utility values.

Conclusion and application of findings: Three genotypes, i.e. Bondokuy-1, Dogona-1 and Douana-1 had high grain yields under both well watered and moisture deficiency conditions. These accessions could serve as potential sources of favorable alleles for developing high yielding varieties adapted to areas affected by drought in West and Central Africa.

Key words: Drought stress, landraces, drought sensitivity index, yield potential, Burkina Faso.

INTRODUCTION

Maize is a major staple food crop grown in different ecological zones of West and Central Africa (WCA). Drought reduces maize grain yields in the humid tropics by 15 to 17% (Edmeades *et al.*, 1992; Waddington *et al.*, 1995; Ashley, 1999). When drought occurs during or shortly before flowering, the estimated yield loss may be in the range of 21 to 50% (Denmead & Shaw, 1960).

Development of cultivars that are tolerant to drought and high temperature stress is therefore a prerequisite to stabilizing maize yields in most parts of West and Central Africa where rainfall is erratic and soils have poor water holding capacity. Since the timing of mid-season drought is unpredictable, maize cultivars that can tolerate the effects of reduced moisture supply around flowering (Fischer *et al*., 1989) would reduce farmers' risk in drought-affected ecologies. In the search for tolerance to stress, plant breeders often consider landraces as potential sources of adaptation to a stress prevailing in a target environment (Bidinger *et al*., 1994). For example, landraces are reservoirs of genes for tolerance to the spotted stem borer - *Chilo partellus* (Ajala *et al*., 1995), low soil-N (Lafitte *et al*., 1996) and drought (Dahlan *et al*., 1997; Badu-Apraku *et al*., 1997; Menkir & Akintunde, 2001). Selection by farmers has resulted in accumulation of genes for resistance to specific stresses that can be utilized by breeders to improve crop cultivars.

Although local varieties of crops have not been extensively used by breeders because of their low yield potential, excessive height and other undesirable agronomic traits, they possess some specific traits including drought tolerance that may not be present in other germplasm (Blum & Sulivan, 1986). Local varieties can thus serve as sources of genes that enhance performance of germplasm through adaptation to drought stress (Beck *et al*., 1997; Menkir & Akintunde, 2001). The first step in achieving this goal is to screen available local maize germplasm under controlled moisture deficiency to identify desirable genotypes with genes to introgress into adapted breeding populations (Boyer, 1982; Landi *et al*., 1995; Menkir & Akintunde, 2001).

The objective of this study was to assess performance of 14 local maize varieties collected from different parts of Burkina Faso under moisture deficiency and well watered conditions.

MATERIALS AND METHODS

Maize seed: Fourteen late maturing maize germplasm accessions collected from farmers' fields in Burkina Faso and a drought tolerant commercial hybrid check were used for this study. The seeds were obtained from the national maize programme of Burkina Faso and were multiplied at the International Institute of Tropical Agriculture (IITA), Ibadan, in Nigeria, through bulk pollination.

Study site: The accessions were evaluated during the dry seasons of 1999 and 2000 at the Ikenne IITA experimental station (6° 53'N, 3 ° 42'E, 60m above sea level). The soil at this location is eutric nitosol (FAO classification) and the experimental fields in the station are flat and fairly uniform. Rainfall during the study period (December to March) was a maximum of 19,6, 0.0, 0.0 and 33.4mm, respectively. Thus the maize crop planted during the period was completely dependent on irrigation.

Trial set up: The 1999 trial was planted on December 12, 1998 while the 2000 trial was planted on December 1, 1999. Each trial was planted in two blocks that received different irrigation treatments. Sprinkler irrigation was used to supply adequate water every week to the two blocks from planting to 23 days before 50% anthesis. One of the blocks which is hereafter referred to as well-watered condition continued to receive irrigation every week until physiological maturity. In the second block, drought stress was imposed by withdrawing irrigation from 23 days before 50% anthesis until harvest.

The trial was laid out in a randomized complete block design (RCBD) with three replications. The genetic materials were planted in 2-row plots, 3 m long, with 0.75 m spacing between rows and 0.25 m spacing between plants. Within a row, two seeds were planted in a hill and thinned to one plant after emergence to attain a population density of 53,000 plants ha^{-1}. A compound fertilizer was applied to supply 60kg N, 60 kg P and 60kg K ha^{-1} at the time of sowing. An additional 60kg N ha^{-1} was applied as top dressing four weeks later. The fields were kept weed free through out the duration of the experiment.

Data collection and analyses: Days to anthesis and days to silking were recorded as the number of days from planting to when 50% of the plants in each plot shed pollen and had emerged silks, respectively. Anthesis–silking interval (ASI) was computed as the difference between dates of silking and pollen shed. Plant and ear heights were measured as the distance (cm) from the base of the plant to the height of the first tassel branch and the node bearing the upper ear, respectively. Plant aspect was rated on a scale of 1 to 5 where 1 = excellent overall phenotypic appeal and 5 = poor overall phenotypic appeal. Ear aspect was also rated visually on a scale of 1 to 5 where 1 = clean, uniform, large and well-filled ears and 5 = variable, small and partially filled ears. Leaf death score was recorded in both well-watered and moisture deficit treatments at 72 days after planting, the period of physiological maturity, on a rating scale of 1 to 10 where 1 = almost all leaves (90%) were green and 10 = virtually (100%) all leaves were dead. The total number of plants and ears were counted in each plot at the time of harvest. The number of ears per plant was then calculated as the proportion of the total number of ears harvested divided by the total number of plants in a plot. All ears harvested from each plot were shelled to determine percent moisture at harvest. Grain yield was adjusted to 15% moisture and used to compute grain yield in tonnes per hectare (t/ha). An index of drought sensitivity (DSI) was used to characterize the relative stress tolerance of all genotypes included in the study. The index was calculated from genotype means using a generalized formula (Fisher & Maurer, 1978; Clarke *et al*., 1984) in which DSI = [(1-YD/YP)] D,

where; YD = χYield (KRWT) in stress environment; YP = χYield (KRWT) in non stress environment = Potential Yield (KRWT);

D (environmental stress intensity) = 1-(Mean YD of all genotypes/Mean YP of all genotypes).

Yield potential (YP) of each genotype was defined as the maximum mean response of each genotype averaged over the two years in the well-watered condition (Bruckner & Frohberg, 1987).

Data collected for each moisture treatment was analyzed separately for each year before a combined ANOVA across years was conducted using PROC GLM of SAS (1997). Principal component analysis (PCA) was computed using the correlation matrix of the traits, except grain yield, recorded in each irrigation treatment to identify traits that contributed the most to the variation in performance. To separate the genotypes based on a combination of traits that determine performance both under moisture deficit and well-watered condition, cluster analysis was computed using the Euclidean distance and the unweighted pair group (UPGA) method.

RESULTS

Genotypic performance under well-watered condition and moisture deficit: Differences among local varieties for grain yield were significant (P ≤0.001) under the two irrigation treatments (Table 1). Variety *x* year interaction was significant only for days to anthesis and leaf death score under moisture deficit and for days to anthesis, ASI and plant aspect under well-watered condition. Differences among varieties were not significant for drought sensitivity index (DSI). Moisture deficit reduced the number of ears per plant by 22% and grain yield by 53%. Conversely, leaf death score and ASI increased under drought stress, while days to anthesis remained unaffected by moisture deficit. Plant and ear characteristics as well as husk cover were affected to some extent. Ranges for grain yield, plant height and leaf death score under well-watered condition were quite large compared to values obtained for the same characters under moisture deficit while ranges in the values for other traits were comparable.

Relative ranking of genotypes for grain yield under well-watered condition was different from that under moisture deficit (Table 2). Yield reduction under moisture deficit varied from 16 to 59%. The hybrid check (Oba Super 2) sustained yield reduction of 57% due to moisture deficiency. The three landraces (Bondokuy-1, Dogona-1 and Douana-1) had grain yields that were comparable to that of the hybrid check under drought stress and well-watered condition. These landraces were also similar to the hybrid check in terms of number of ears per plant, ear aspect and leaf death scores. However, Dogona-I and Douana-1 had significantly higher ear placement than Oba Super 2.

Correlation among traits in well-watered and moisture deficiency conditions: The correlation of traits between years was positive and significant for all traits except for ASI and husk cover under well-watered condition (Table 3). Means of all traits recorded in the two years under moisture deficit were also significantly correlated except for ASI, plant height, plant aspect and husk cover. Correlations of traits under well-watered condition with the same traits under moisture deficit were positive and significant except for ASI, husk cover and ears per plant (Table 3). The correlation of DSI with other traits recorded under moisture deficit was not significant except with number of ears per plant (Table 4). Leaf senescence and ear aspect had negative and significant associations with days to anthesis and silking as well as plant height but their association with plant aspect was significant and positive. Leaf senescence also correlated positively with ear aspect. Ears per plant on the other hand, correlated negatively with ASI (Table 3).

Table 1: Means of traits averaged over two years, their standard errors as well as the corresponding ranges and coefficients of variation (%CV) for 15 late maturing maize varieties grown under well-watered and moisture deficit conditions at Ikenne, Nigeria in 1999 and 2000.

Trait *Well-watered*	Days to anthesis (days)	Days to silk (days)	ASI (days)	Plant height (cm)	Ear height (cm)	Plant aspect (1-5)	Ear aspect (1-5)	Husk cover (1-5)	Ears /plant (nos)	Grain yield (t/ha)	Leaf death score
Mean	50	52	2.0	213	122	3.8	2.9	3.0	0.9	3.39	3.6
SE	0.6	0.5	0.2	5.3	3.5	0.5	0.2	0.2	0.05	0.20	2.2
Range	11	10	2.0	56	37	2.6	2.0	1.2	0.5	3.73	8.2
CV (%)	1.8	2.1	31.6	7.7	13.0	11.1	16.8	16.6	10.1	13.7	12.8
Var	***	***	ns	**	**	ns	**	Ns	*	***	***
Var x Year	Ns	*	*	ns	ns	***	ns	Ns	ns	ns	ns
Drought											
Mean	50	54	4.2	196	109	3.7	3.2	2.9	0.7	1.59	7.9
SE	0.5	0.9	0.8	5.7	5.2	0.4	0.1	0.2	0.04	0.16	0.5
Range	11	11	2.7	41	35	2.3	1.3	1.2	0.4	1.49	2.7
CV (%)	1.6	2.9	32.0	7.2	14.3	19.4	12.1	15.7	15.0	29.2	9.5
Var	***	**	ns	ns	*	ns	**	ns	**	**	*
Var x Year	*	ns	ns	ns	ns	ns	ns	ns	ns	ns	*
+Differential(5)	0.0	3.7	52.38	7.98	6.10	2.63	-9.38	3.33	22.22	53.04	-54.43

*, **; Significant F-Test at $p<0.05$ and $p<0.001$ levels, respectively; +Difference between well-watered and drought condition expressed as % of former; ASI = Anthesis-silking interval; leaf death score is 1 – 10.

Contributions of traits under well-watered condition and moisture deficit: The first two principal components (PC) together accounted for 82 and 80 % of the total variations among entries under both well-watered condition and moisture deficiency, respectively (Table 5). The signs for the loadings of the various traits in PC1 were similar under the two moisture regimes except for ASI and number of ears per plant, which had very low scores under moisture deficiency. In the two environments, leaf senescence was the most important trait that contributed to PC1 while number of ears per plant was the most important trait contributing to PC2. PC1 accounted for 67 and 54% of the total variation among entries under well-watered condition and moisture deficiency, respectively. PCI scores were associated with early flowering, reduced plant height and number of ears per plant, poor plant and ear aspects scores as well as longer ASI and increased leaf senescence. PC2 accounted for 15 and 26% of the total variation among entries under well-watered condition and moisture deficit, respectively, and was associated with late flowering, reduced number of ears per plant under both irrigation treatments, tall plants under full irrigation and longer ASI under drought stress.

Table 3: Correlations of traits between years under well-watered condition and moisture deficit of maize landraces evaluated at Ikenne, Nigeria in 1999 and 2000.

	Well-watered	**Drought stress**
Days to anthesis	0.90**	0.93**
Days to silk	0.89**	0.81**
ASI	0.20	-0.09
Plant height	0.78**	0.47
Ear height	0.79**	0.62*
Plant aspect	0.58*	0.18
Ear aspect	0.79**	0.71**
Husk cover	0.26	0.45
Root Lodging	-0.33	-0.10
Stalk Lodging	0.50*	0.75**
Ears per plant	0.52*	0.77**
Grain yield	0.92**	0.76**
Leaf death score	-	0.66**

*, **; Significantly different from zero at $p<0.05$ and $p<0.001$ levels, respectively. ASI = anthesis-silking-interval

Table 2: Means averaged over two years for grain yield (under well-watered and drought stress) as well as flowering and agronomic traits under drought stress condition in 15 late maturing maize varieties at Ikenne, Nigeria in 1999 and 2000.

	Grain yield (t/ha^{-1})		Drought stress										
Genotypes	Well-watered	Drought stress	Days to anthesis	Days to silk	ASI (days)	Plant Height (cm)	Ear height (cm)	Plant aspect	Ear aspect	Ears per plant	Leaf death score	Yield reduction (%)	DSI (%)
Nabou-1	1.19	1.00	44	48	4.1	202	90	4.2	3.7	0.8	9.6	16	0.30
Tirpo-2	3.59	1.89	50	54	3.9	206	122	3.4	3.1	0.7	7.3	53	0.89
Tirpo-5	3.24	1.38	50	54	4.5	186	94	4.0	3.4	0.7	7.9	59	1.08
Logogueue-1	3.41	1.66	50	53	3.3	201	113	3.8	3.2	0.8	8.1	51	0.97
Douna-2	3.76	1.81	50	53	3.4	200	104	4.3	3.1	0.9	7.9	52	0.98
Kapale-1	3.92	1.65	53	58	5.6	199	123	2.9	3.0	0.6	7.1	58	1.09
Bondokuy-1	3.91	2.16	50	53	3.2	200	111	3.8	3.0	0.9	7.4	45	0.85
Samorogouan-5	4.55	1.88	51	57	5.8	205	111	3.7	2.8	0.8	6.9	59	1.11
Kawara-8	3.01	1.29	55	59	4.0	209	117	4.0	3.0	0.6	7.7	57	1.08
Diassaga-1	3.25	1.81	50	53	3.1	191	105	4.0	3.0	0.8	8.4	44	0.84
Dogona-1	4.79	2.10	52	56	4.0	205	122	3.1	2.9	0.8	6.8	56	1.06
Dou-1	4.56	1.99	52	57	4.7	193	125	3.7	3.0	0.7	7.1	56	1.07
KD46	1.27	0.67	47	52	5.1	168	92	4.3	3.9	0.7	9.5	47	0.89
KD 40	1.62	0.73	48	54	5.3	181	97	4.9	3.8	0.5	9.7	55	1.03
Oba super 2	4.92	2.14	52	56	4.1	196	112	2.6	2.6	0.8	7.0	57	1.07
Mean	3.39	1.59	50	54	4.2	196	109	3.7	3.2	0.7	7.9		
LSD (0.05)	0.59	0.46	0.001	0.003	0.002	0.02	0.01	0.001	0.0003	0.0001	0.001		
CV (%)	14	29	2	3	32	7	14	19	12	15	10		

ASI = Anthesis-silking-interval

Table 4: Correlations between traits under moisture deficiency condition in 15 late maturing landraces evaluated at Ikenne, Nigeria in 1999 and 2000.

	Days to anthesis	Days to silk	Plant height	Plant aspect	Ear aspect	ASI	Ears Per Plant	Leaf death score
DSI	-0.02	-0.04	-0.03	0.29	0.25	-0.07	-0.53*	0.33
Days to anthesis		0.95**	0.43	-0.49	-0.74**	0.03	-0.19	-0.76**
Days to silk			0.31	-0.47	-0.63*	0.34	-0.36	-0.71**
Plant height				-0.44	-0.65*	-0.31	0.30	-0.60*
Plant aspect					0.75**	-0.07	-0.19	0.79**
Ear aspect						-0.22	-0.38	0.91**
ASI							-0.60*	0.04
Ears Per plant								-0.27

*, **; Significantly different from zero at p<0.05 and p<0.001 levels, respectively
ASI = Anthesis-silking-interval

Table 5: Eigen vectors of the first two principal component axes (PC1 & PC2) for well-watered condition and moisture deficit of maize landraces evaluated at Ikenne, in Nigeria in 1999 and 2000.

	Well-watered		Moisture deficiency	
Character	PC1	PC2	PC1	PC2
Days to anthesis	-0.383	0.383	-0.415	0.236
Days to silk	-0.362	0.442	-0.380	0.396
Plant height	-0.315	0.487	-0.328	-0.243
Plant aspect	0.395	0.276	0.379	0.045
Ear aspect	0.394	0.177	0.458	0.140
ASI	0.246	0.184	0.038	0.570
Ears per plant	-0.301	-0.512	-0.083	-0.618
Leaf death score	0.400	0.183	0.462	0.032
Proportion of variance	0.673	0.151	0.536	0.261

ASI = Anthesis-silking-interval

Grouping of genotypes under well-watered condition and moisture deficiency: The local varieties formed two major clusters under both well-watered condition and moisture deficiency (Figures 1 and 2). Under well-watered condition, three of the highest yielding entries (Oba Super-2, Dogona-1 and Douana-1) formed a major cluster with four low yielding entries (Figure 1). The top three entries Oba Super–2, Dogona-1 and Bondokuy-1 also formed a major cluster with five low yielding entries under moisture deficiency (Figure 2). Genotypes included in cluster 2 had shorter ASI, lower rating for leaf senescence and higher yield than genotypes included in cluster 1 (Table 6). The genotypes included in cluster 2 were also taller and had higher ear placement than the genotypes in cluster 1.

Comparison between the top and lowest yielding genotypes: The three top yielding genotypes had lower leaf senescence than the three lowest yielding genotypes under moisture deficiency (Table 7). The top yielding genotypes were also characterized by reduced ASI under moisture deficiency. Although plant height was reduced in the genotypes under moisture deficiency, the top yielding genotypes, except Douana-1, had higher ear placement under well-watered condition while the reverse was the case for the lowest yielding entries.

DISCUSSION

The maize accessions used in this study varied in their yielding ability under both well-watered condition and moisture deficiency. Apart from reduction in plant height and delay in silk emergence, moisture deficiency reduced grain yield significantly. Previous studies (Moss & Downey, 1971; Hall *et al*., 1981; Quattar *et al*., 1987; Sobrado, 1990) have shown that maize grain yield is significantly reduced under moisture deficit due to asynchrony between male and female flowers resulting from a delay in silk emergence relative to emergence of anthers (Herelo & Johnson, 1981; Hall *et al*., 1982; Westgate & Boyer, 1986; Bolaños & Edmeades, 1993; Edmeades *et al*., 1993).

Table 6: Means of characters of maize landraces evaluated at Ikenne, in Nigeria in 1999 and 2000, comparing two clusters under well-watered condition and moisture deficiency.

Character	Well-watered		Moisture stressed	
	Cluster 1 (n = 8)	Cluster 2 (n =7)	Cluster 1 (n = 7)	Cluster 2 (n =8)
Grain yield (t/ha^{-1})	3.18	3.59	1.47	1.77
Days to anthesis*	50	50	50	50
Days to silk*	52	52	55	54
ASI*	2.1	1.9	4.4	4.1
Plant height (cm) *	210	215	195	197
Ear height (cm)	108	115	108	111
Plant aspect*	3.9	3.6	3.7	3.8
Ear aspect*	3.0	2.8	3.2	3.1
Ears per plant*	0.9	0.9	0.7	0.8
Root lodging	1.4	1.3	1.7	1.7
Stem lodging	3.9	3.0	5.3	4.5
Husk cover	2.9	3.2	2.9	2.9
Leaf death score*	4.7	2.7	8.1	7.6

*; Characters used in constructing Euclidean distance under well-watered condition and moisture deficiency.
ASI = Anthesis-silking-interval

Although, days to anthesis remained unaffected by drought stress, ASI was delayed by 3 days. ASI is a valuable diagnostic trait for cultivar performance under stress than days to silking *per se* (Fischer *et al*., 1983), since it is largely independent of maturity differences among cultivars (Edmeades *et al*., 1989). The number of ears per plant decreased significantly as ASI increased, and this trait was a major factor that contributed to differences between the top and lowest yielding genotypes under drought stress. The extent of leaf senescence was also significantly high under moisture deficiency compared to that under well-watered condition.

The three lowest yielding genotypes lost almost their entire green leaf area under moisture deficiency and could no longer maintain photosynthetically active leaves. This resulted in very low grain yields, similar to the observation of Rosenow *et al*. (1983) and McBee (1984). Conversely, the three top yielding genotypes had lower rate of leaf senescence, which probably enhanced their stress tolerance by increasing the assimilate supply for grain filling (van Oosterom *et al*., 1996). A drought resistant genotype can be described as one that has a higher grain yield than others when exposed to the same level of water stress (Fukai & Cooper, 1995) or with high value under high stress relative to that under low stress (Blum *et al*., 1992). Maize cultivars Bondokuy-1, Dogona-1 and Douana-1 had high yield potential under both well-watered condition and moisture deficiency. The three genotypes had lower yield loss under moisture deficit in comparison with the hybrid check and thus may serve as sources of alleles for the development of drought tolerant varieties. Although genotypes with low DSI can be considered to be drought tolerant because they exhibit smaller yield loss under drought (Bruckner & Frohberg, 1987), they failed to translate this advantage into high grain yield primarily because of their unimproved state with respect to biomass partitioning into the grain (Blum *et al*., 1992). This is particularly true for Nabou-1 which had the lowest DSI (0.30) but had poor grain yield even under favorable growing conditions. Conversely, Bondokuy-1 had relatively high DSI (0.85) combined with high mean yields under well-watered condition and moisture deficiency and thus has a great potential as a source of alleles for drought tolerance and high grain yield potential (Beck *et al*., 1997; Menkir & Akintunde, 2001).

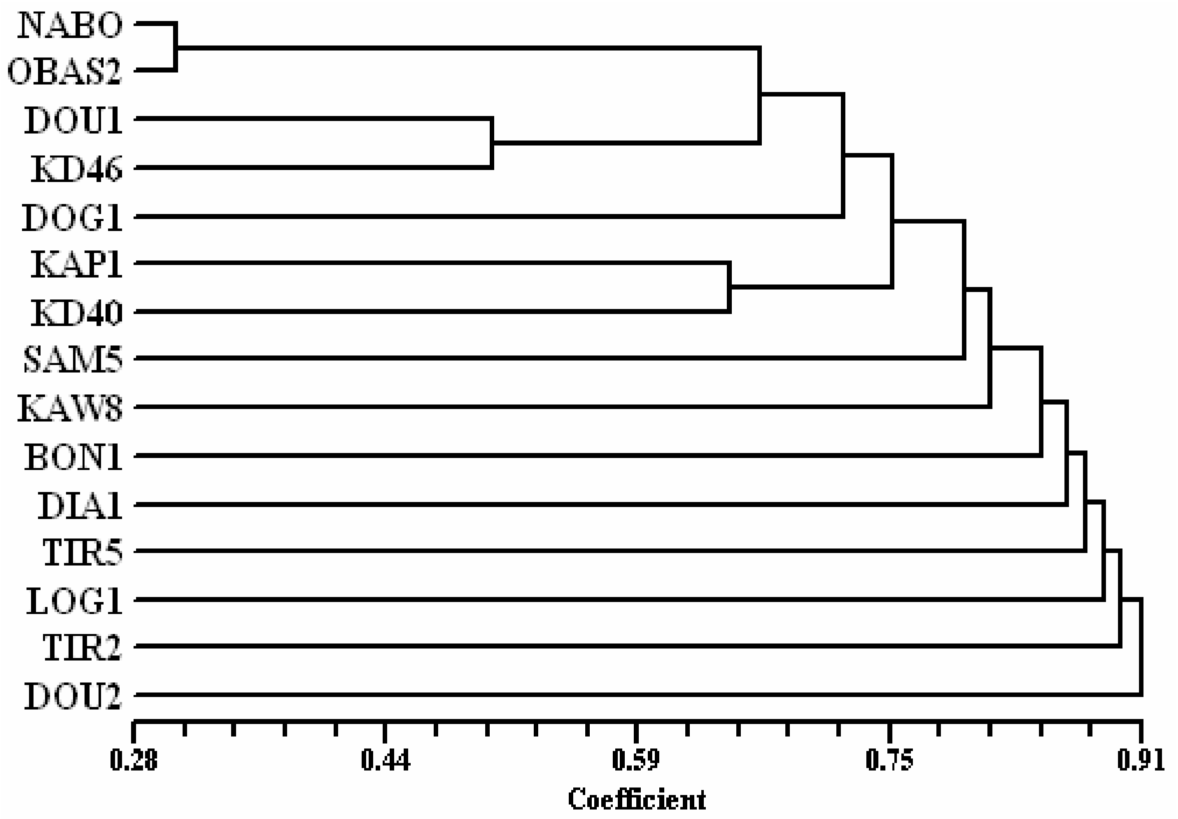

Figure 1: Dendogram of 15 maize accessions based on UPGA in well-watered environment.

Usually, landraces have undesirable agronomic features. Thus, the use of such landraces as sources of genes for tolerance to stresses may result in the transfer of undesirable agronomic traits to breeding populations (Blum & Sulivan, 1986) due to pleiotrophy or linkage. However, many of the landraces evaluated in this study had yield potential and agronomic traits that were comparable to the hybrid check under both well-watered and moisture deficit conditions. Since these genotypes have been in farmers' fields in Burkina Faso, there exists the possibility that they contained genes derived from improved varieties cultivated in the region through constant gene flow from neighboring farms. Therefore, the high yielding genotypes under moisture deficit could serve as potential sources of unique combinations of favorable alleles derived from both landraces and improved cultivars for developing high yielding varieties adapted to drought affected areas in West and Central Africa.

Table 7: Means averaged over two years for flowering and agronomic traits of three top and lowest yielding entries under well-watered condition and moisture deficit at Ikenne, Nigeria (1999 and 2000).

Genotype	Days to silk		ASI		Ear Height (cm)		Ears per plant		Ear aspect		Stalk lodging		Leaf death score		rain yield (t/ha^{-1})	
	WW	DSS	WW	DS	WW	DS	WW	DS	WW	DS	WW	DS	WW	DS	WW	DS
								Top yielding entries								
Bondokuy1	52	54	2.0	4.3	111	112	1.0	0.9	2.7	3.1	3.4	4.0	3	7.4	4.0	2.13
Dogona-1	53	56	1.8	3.5	111	122	0.9	0.8	2.4	3	2.0	4.9	1.7	6.8	4.7	1.95
Dou-1	55	57	1.7	3.3	127	118	1.0	0.7	2.9	3	2.2	3.9	1.7	7.1	4.4	2.00
								Lowest yielding entries								
Nabou-1	46	48	3.0	6.7	99	93	0.8	0.8	3.8	3.8	4.8	7.3	9	9.6	1.4	1.00
KD46	49	51	2.5	7.2	96	98	0.7	0.7	3.8	3.9	6.3	8.2	8.3	9.5	1.5	0.80
KD 40	49	53	2.0	6.5	101	102	0.8	0.5	3.8	3.8	7.1	7.3	8.7	9.7	1.6	0.77
Check mean	53	56	1.2	4.1	98	112	1.1	0.8	2.0	2.6	2.1	2.6	0.9	7	4.92	2.14
LSD ∞0.05	1.50		1.05		23.10		0.19		0.75		1.93		0.56		0.73	
%CV	2.48	4.26	43.49	40.15	18.03	12.65	18.49	19.26	19.44	10.35	37.75	37.83	8.75	10.36	20.76	40.07
Variety	***	***	*	ns	ns	**	*	**	***	***	***	**	***	***	***	***

*, **, *** Significant F-Test at p<0.05, p<0.01 and p<0.001 levels, respectively. ASI = Anthesis – silking interval.
WW = Well-watered; DS = Drought stress.

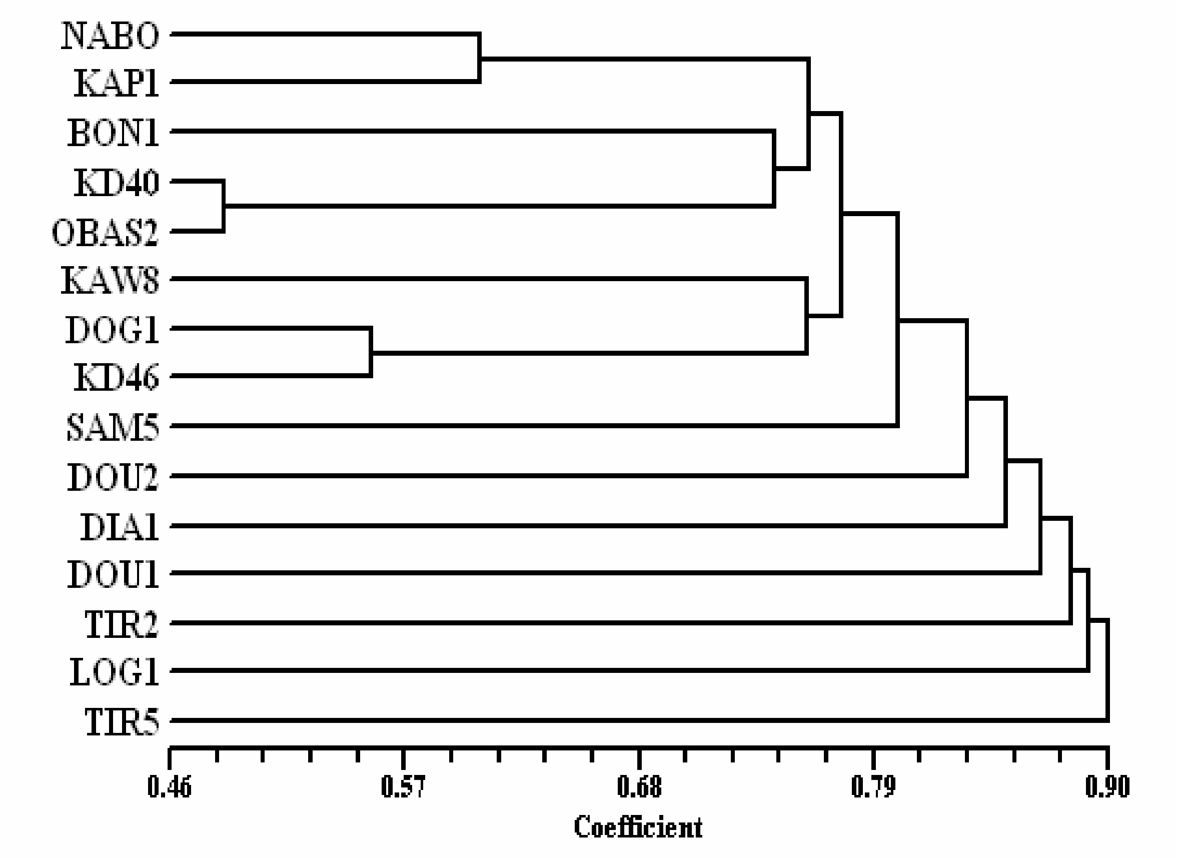

Figure 2: Dendogram of 15 maize accessions based on UPGA in moisture deficient environment.

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