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Variation in pod yield characters and heritability estimates in some accessions of Bambara groundnut (*Vigna subterranea* (L.) Verdc.

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Variation in pod and seed yield among twelve accessions of Bambara groundnut was investigated in 2004 and 2005 cropping seasons. The mean performance revealed that BG7004AS despite its recorded low number of pods per plant, had the highest 100 seed weight, pod width, pod length, seed width and seed length, followed by BG7002AS, BG7009BS and BG70010AS, which had the best yield and yield component attributes, indicating their suitability for hybridization. The analysis of variance revealed significant differences (p<0.05) among the cultivars for most of the characters evaluated. The genotypic coefficient of variation ranged from 3.29 for plant height at 8 weeks after sowing to 26.15 for 100 seed weight, while the phenotypic coefficient of variation ranged from 4.93 for shelling percentage to 26.56 for 100 seed weight. Furthermore, estimates of genotypic and phenotypic coefficient of variation as well broad sense heritability were also high for characters such as pod number per plant, pod yield per plant, seed yield per plant, seed length and seed yield per hectare in 2004 relative 2005. Seed length, pod length and pod width recorded 100% broad sense heritability estimates and high genetic advance, indicating that these characters are under additive genetic control and selection for improvement will be worthwhile and may rapidly contribute to increased seed yield in bambara groundnut cultivars.

Keywords: Variation, heritability, genetic advance, genotypic and phenotypic coefficient of variation and seed yield.

INTRODUCTION

Bambara groundnut (*Vigna subterranea* (L.) Verdc) belongs to the family fabaceae, subfamily *papilionoideae* (Verdcourt, 1980). It is the third most important grain legume after groundnut (*Arachis hypogea* L.) and cowpea (*Vigna unguiculata* [L]. Walp) in Sub-Sahara Africa (Rachie and Silvestre, 1977). The annual world production is 330,000t, 45-50% of which are produced in West Africa (Nigeria, Niger, Burkina Faso, Chad, Cote d'Ivoire, Ghana and Mali) (PROTA, 2006). Bambara groundnut is cultivated primarily for its subterranean pods (Linnemann and Azam-Ali, 1993); rich in protein which helps to alleviate nutritional disorders in human and livestock (Massawe *et al*., 2002). Immature seeds of bambara groundnuts are often boiled with salt and eaten as a snack; vegetable milk and fermented products such as ''dawadawa'' (*Parkia biglobosa* (Jacq.) can be made from the seeds (PROTA, 2006). Bambara groundnut fixes atmospheric nitrogen through symbiosis with *Rhizobium* bacteria and therefore beneficial in crop rotations and intercropping (Mukumbira 1985; Karikari *et al*., 1999). Constraints in production of bambara groundnut in Nigeria includes poor quality seeds, low germination and poor nodulation, instability in fodder and seed yield among others.

Genetic studies in bambara groundnut is limited in Nigeria, this trend is associated with little preference for this crop among researchers when compared with crops like cowpea and groundnut, (Kadams and Sajo, 1998). Little attempts have been made to improve this crop through conventional breeding and selection, because the crop is an important staple and economic among farmers. Most cultivated varieties in sub Sahara Africa are largely products of introduction and selection, while hybridization in this crop is limited (Massawe *et al*; 2003).

Genetic variability is an essential prerequisite for crop improvement programme for obtaining high yielding varieties, through the estimation of different genetic parameters like components of variances, genotype and phenotype coefficient of variability heritability and genetic advance (Younis *et al*; 2008). In genetic studies, characters with high genotypic coefficient of variation indicate the potential for an effective selection (Sadiq *et al.,* 1986). Determining the components of variability in yield and its components enable us to know the extent of environmental influence on yield, taking into consideration of the fact that yield and its component are quantitative characters that are affected by environments (Ahmed *et al*., 2007). Heritability provides an idea to the extent of genetic control for expression of a particular character and the reliability of phenotype in predicting its breeding value (Chopra, 2000 and Tazeen *et al*., 2009) and heritability provides information about the extent of which a particular genetic character can be transmitted to the successive generations (Mangi *et al*., 2010). High heritability indicates less environmental influence in the observed variation (Mohanty, 2003 and Eid, 2009). Heritability value alone cannot provide information on amount of genetic progress that would result from selection of best individuals. Johnson *et al*; (1955) reported that heritability estimates along with genetic advance would be more successful in predicting the effectiveness of selecting the best individuals. Genetic advance which estimates the degree of gain in a trait obtained under a given selection pressure is an important parameter that guides the breeder in choosing a selection programme (Hamdi *et al*., 2003). High heritability and high genetic advance for a given trait indicates that it is governed by additive gene action and, therefore, provides the most effective condition for selection (Tazeen *et al*., 2009) For breeding program to improve pod yield in bambara groundnut, it is essential that plant characters that determine productivity be identified. Therefore, the information on the nature and extent of genetic variability and transmission of traits is of paramount importance in enhancing the efficiency of selection for seed and pod yield. This study was undertaken to estimate the extent of genetic variability and heritability study in bambara groundnuts.

MATERIALS AND METHODS

Entries of twelve accessions of Bambara groundnut (Table 1) used in this study were collected from farmers' in the north eastern Nigeria; they had been maintained in the Department of Crop Science and are true-to-type.

Five accessions namely BG7001BS, BG7006BS, BG7007BS, BG7009BS and BG70012BS were source from farmers' collection in Gwoza, Borno State, Nigeria. BG7002AS, BG7003AS, BG7004AS, BG7005AS, BG7008AS, BG70010AS and BG70011AS were sourced from farmers' in Mubi/Hong; Adamawa state. Field evaluation was carried out at the teaching and research farm, Adamawa State University Mubi, Nigeria (10^0 3'N and 13^0 7'E), in the July 2004 and 2005 cropping season. This period coincide with the planting season for bambara groundnut in this location. The experiment was laid out in a randomized complete block design with three replications, plot size was $10m^2$ and a total experimental area was $595m^2$. The experimental site was ploughed and harrowed, two seeds of each cultivar were sown at 0.5m between plants, a total of 64 plants were established per plot.

Weeding was done manually at 4 and 8 weeks after sowing. Fertilizer application of 60kg super phosphate per hectare was applied 3 weeks after planting as recommended by Hepper (1970), Benomyl was sprayed at the rate of 30g/20L of water, at the 5^{th} and 6^{th} week after sowing to control fungal disease. Data were collected on plants within the two middle rows to reduce border effects. Characters measured includes: plant emergence and emergence percentage at 2 weeks after sowing. Plant height (cm) at 8 weeks after sowing was measured from the ground level to the leave tip on ten randomly selected plants. Prior to harvest, the number of plants was estimated. The number of pods per plant was the mean number of pods of ten randomly selected plants, and pod yield per plant was taken as the mean number of harvested pods of ten randomly selected plants after drying. Seed yield per plant was estimated as the average weight (g) of seeds of the ten randomly selected plants on each plot after winnowing. Weight of hundred seeds was estimated by weighing 100 clean and uniform seeds picked randomly from the bulk of seeds harvested per plot.
Shelling percentage was computed as below

$$\frac{Weight\ of\ dry\ seed\ (g)}{Weight\ of\ dry\ pods\ (g)} \times 100 .$$

Pod width and length were measured (cm) using Venier calipers from ten randomly selected pods per plot. Similarly both length and width of seeds were measured. The seed yield (kg/ha) was determined on plot basis and this was extrapolated to kilogram per hectare.

Table 1: Description of the cultivars used in the study.

Entry name	Local name	Area of collection	State	General characteristics
BG7001BS	Danngwaji	Gwoza	Borno	Creamy colour, dominated by black stripes, smooth shiny seed coat with white eye
BG7002AS	Gurlela	Mubi	Adamawa	Creamy colour, oval shaped with smooth shiny seed coat and white-eye, which is surrounded by sky-blue colour.
BG7003AS	Idon Kule	Mubi	Adamawa	A creamy colour having few spotted light brown colour, smooth shiny seed coat with white-eye, surrounded by patches of light brown/black colour.
BG7004AS	Bambwus	Mubi	Adamawa	Creamy colour, having brown stripes, smooth shiny seed coat, white eye surrounded by sky blue colour
BG7005AS	Tanyanyi	Mubi	Adamawa	Light brown having dotted black colours, oval shaped, smooth shiny seed with white eye.
BG7006BS	Kara Magdanda	Gwoza	Borno	Brown colour seed with creamy patches mostly surrounding the eye, oval shaped with white eye
BG7007BS	Indara Ayaghayagha	Gwoza	Borno	Completely black, oval shaped, smooth seed coat with white-eye.
BG7008AS	KwadaZwalang	Hong	Adamawa	Completely white, round shaped, smooth shiny seed with white-eye.
BG7009BS	Wacha Ghagha	Gwoza	Borno	Creamy colour, having black stripes, smooth shiny seed coat, with white-eye that is surrounded by blue/brownish colour.
BG70010AS	Kurvu	Hong	Adamawa	Completely dark red, oval shaped shiny smooth seed coat with white-eye.
BG70011AS	Wada hoba shen	Hong	Adamawa	Light brown shiny seed coat with white-eye.
BG70012BS	Achaghwaghwa	Gwoza	Borno	Creamy colour, round shaped with white eye surrounded by dark brown colour having few brown stripes.

The mean for each trait over three replication and two years was computed for each cultivar and used for analysis using PROC MEANS using PROC GLM procedure of SAS (1999).

Broad sense heritability was computed using the method of Singh and Chaudhary ,1985 and Moll *et al.*, (1960) as below:

$$H_B = \frac{\delta_g^2}{\delta_p^2}$$

$$\delta_g^2 = \frac{M_g - M_e}{r}$$

$$\delta_p^2 = \delta_g^2 + \delta_e^2$$

Where:

H_B = broad sense heritability,

$\delta_g^2 = genotypic\ variance$

$\delta_p^2 = phenotypic\ variance$

δ_e^2 = Error variance

M_e = Mean square error

M_g = Mean square genotype

r = Number of replication

PCV and GCV were estimated using the procedure of Burton and De Vane (1953) as follows:

$$PCV = \frac{\sqrt{\delta_p^2}}{\bar{x}} \times 100$$

$$GCV = \frac{\sqrt{\delta_g^2}}{\bar{x}} \times 100$$

Where:

PCV = Phenotypic coefficient of variation

GCV = Genotypic coefficient of variation
$\bar{x}$ = Grand Mean
δ_p^2 = Phenotypic variance
δ_g^2 = Genotypic variance
The genetic advance was calculated according to Allard's (1964) and was estimated from the following formula:
$GA = ih^2V_p$
Where i= 1.76 (10% selection intensity)
V_p = phenotypic variances
h^2 = heritability

RESULTS AND DISCUSSION

Mean seed yield among the accessions ranged between 1.66 and 2.82tonnes/ha (Table 2), this provides basis for selection among the accessions. From the mean performance, BG7002AS, BG7009BS, BG70010AS and BG7004AS showed clear superiority in terms of yield and yield component attributes. The combined analysis of variance (Table 3) for seed yield and other agronomic characters showed significant genotype effects for agronomic characters, thus indicating that bambara accessions were highly variable in performance for agronomic characters. The presence of variability in crop is important for genetic studies and consequently improvement and selection. The significant difference in yield and agronomic characters among the accessions gives room for selection of superior ones (Agbo and Obi, 2005). Significant year (Y) effects ($P<0.05$) indicates the presence of variability in the environmental variables (Temperature, rainfall, humidity, sunshine) for both years of evaluation (Appendix 1 and 2). It had been noted that unpredictable changes in weather have been described as essential in crop improvement (Falconer, 1989). Significant Genotype by Year interaction ($P<0.05$) was observed for all characters evaluated. Thus confirming inconsistencies in the performance of the bambara groundnut cultivars over the years of evaluation. Several studies have highlighted the presence of genotype by environment interaction in crops; in okra (Ariyo, 1987), cassava (Otoo *et al.,* 1994) and maize (Kang and Gorman 1989). This necessitates the selection of crops for specific environment, wherein stability over environments is poor. Therefore inconsistencies in seed yield and agronomic characters over years implied that farmers must have been discouraged by this phenomenon which might have accounted for yield losses.

Table 4 shows the mean, range, genotypic and phenotypic coefficient of variation, estimates of broad sense heritability (H_B) and genetic advance of seed yield and related characters on yearly basis. The mean performances for most characters were higher in 2005 compared to 2004. The number of pods per plant, 100 seed weight and seed yield/ha were higher in magnitude compared with the 2005 evaluation. The relative amount of variability in a population is best expressed in term of genotypic coefficient of variation, since this variable takes into account the mean values as well as the unit of measurement. Results from the analysis of variance showed that estimates of genotypic and phenotypic coefficient for 100 seed weight were higher in 2004 than 2005 evaluation. The lowest genotypic coefficient of variation was recorded for seed width in both years of evaluation. A high variability observed in this study can be exploited by selection (Burton and de vane, 1953 and Uguru, 1995). Phenotypic coefficient of variation was higher than the corresponding genotypic coefficient of variation, indicating the influence of genotype x environment interaction in the expression of all the character (Uguru, 1995). The relatively small difference observed between the PCV and GCV may be associated with genetic difference for these characters. Similar results have been reported in *Abelmoschus esculentus* (Ariyo *et al.,* 1987)
The genetic variability for most characters of the accessions measured was lower than the phenotypic variance in both years of evaluation. This indicates that the environment influenced all the characters at different magnitude. In the same vein the PCV was higher than the GCV in all the characters in both years of evaluation as earlier reported by Uguru (1995) and Agbo and Obi (2005) in vegetable cowpea and lines of rice respectively.

Broad sense heritability (H_B) was high for most characters in year 2005 relative to 2004. Yield components like number of pod per plant, pod yield per plant, seed yield per plant and 100 seed weight recorded high heritability values for the individual years of evaluation. Pod width and length and seed width recorded 100% H_B in each year of evaluation. Allard (1960) had noted that 100% heritability implies that the phenotype could provides a perfect measure of the genotype value and therefore such characters will respond to selection. Broad sense heritability estimates and genetic advance were high for most characters, exception was recorded in plant height at eight weeks after seeding and seed yield ha^{-1}, which recorded moderate heritability estimates. From this high heritability values coupled with high genetic advance observed, it can be concluded that all these traits are controlled by additive type of gene action as reported by other workers (Johnson et *al*; 1955; Panse, 1957 and Yadav *et al*; 2003). Similar results were also obtained by Gowda *et al.,* (1997) in blackgram. Therefore, improvement for these traits can be achieved through mass selection.

Table 2**:** Mean performance of twelve Bambara groundnut accessions *(Vigna Subterrane) evaluated at* Mubi in 2004 and 2005

Entry name.	GC2wk	GP2wk	Ht8wk(cm)	SC	PN/plt	PYplt(g)	SY/plt(g)	100wt(g)	SP(%)	PW(cm)	PL(cm)	SW(cm)	SL(cm)	SY/ha(t)
BG7001BS	37.50d	58.60d	15.15abcd	33.67d	51.00cd	56.02cd	38.68c	84.85cd	71.58a	1.43cd	1.98d	1.03e	1.26cd	1.63f
BG7002AS	53.50ab	83.58a	14.42bcd	52.50abc	57.35bc	87.05a	53.02a	90.85c	64.03d	1.64a	2.09c	1.09c	1.26cd	2.82a
BG7003AS	47.00bc	71.15bc	15.52abc	46.17c	64.72a	58.23cd	38.70c	68.77f	71.32a	1.13g	1.53h	1.04de	1.23de	2.09bcdef
BG7004AS	36.00d	56.28d	13.73de	34.00d	34.03e	60.63c	36.98c	137.82a	67.62bc	1.65a	2.31a	1.26a	1.52a	1.66f
BG7005AS	56.17a	87.75a	15.15abcd	54.50ab	48.55d	43.73e	26.65d	55.02g	66.28cd	1.44cd	1.80e	0.99f	1.17e	2.15bcde
BG7006BS	37.50d	83.60a	14.97abcd	52.50abc	45.98d	56.65cd	35.92c	81.28d	64.66cd	1.40d	1.78e	1.08cd	1.31c	1.69ef
BG7007BS	53.17ab	83.07ab	16.17a	52.17abc	62.27ab	58.07cd	38.75c	71.90f	70.83a	1.11g	1.64g	0.97f	1.23de	1.92cdef
BG7008AS	52.83ab	82.58ab	14.08cde	51.83abc	46.67d	54.05cd	38.22c	80.90de	63.50d	1.32e	1.70fg	1.06cde	1.19de	1.77ef
BG7009BS	50.00abc	78.13abc	15.68abc	48.33abc	34.27e	53.27cd	38.32c	117.17b	70.15ab	1.46c	2.26a	1.19b	1.47ab	2.53ab
BG70010AS	48.67abc	76.03abc	15.02abcd	54.83a	49.32d	68.48b	41.65bc	85.68cd	63.42d	1.54b	2.18b	1.06cde	1.45b	2.25bcd
BG70011AS	53.83ab	84.12a	16.12ab	52.83abc	66.30a	70.17b	45.67b	69.37f	71.02a	1.31e	1.71f	0.98f	1.18e	2.31bc
BG70012BS	44.50c	69.53c	12.75e	47.17bc	47.87d	51.60d	35.40c	74.32ef	70.55ab	1.24f	1.54h	1.06cde	1.22de	1.84def
Grand Mean	47.56	76.20	14.90	48.38	50.69	59.83	39.00	84.83	67.91	1.39	1.88	1.07	1.29	2.06

Means in a column followed by the same letters do not differ significantly from each other at P = 0.05

Table 3**:** Combined analysis of variance for fourteen agronomic characters in Bambara groundnut (*Vigna subterranea*) for 2004 and 2005 cropping season.

Source of Variation	D.F	PE2wk	EP2wk	Ht8wk	SC	PN/plant	PY/plant	SY/plant	100wt	SP	PW	PL	SW	SL	SY/ha
Year	1	824.90**	1994.54**	3.30^{NS}	768.99**	1602.73**	289.46*	8.83^{NS}	148.81*	240.06**	0.002^{NS}	0.006^{NS}	0.001^{NS}	0.002^{NS}	0.005^{NS}
Replication	2	114.14	311.12	1.63	66.05	19.02	64.23	44.10	102.85	2.61	0.001	0.003	0.001	0.001	0.036
Genotype	11	249.70**	617.90**	6.02**	310.70**	664.78**	740.76**	233.60**	3044.69**	67.24**	0.184.**	0.458**	0.043**	0.087**	0.819**
Genotype x Year	11	32.72^{NS}	80.64^{NS}	4.60**	47.47^{NS}	143.40**	100.70*	23.06^{NS}	91.23**	20.45**	0.0001^{NS}	0.0021^{NS}	0.0040**	0.0061*	0.0725^{NS}
Error	22	35.81	87.26	1.61	30.69	32.13	42.00	27.01	32.07	6.20	0.0010	0.0030	0.0012	0.0029	0.1208

NS = Not significant, * = Significant at (P = 0.05), ** = Significant at (P = 0.01)

PE2WK = Plant emergence at 2WAS, EP2WK = Emergence Percentage at 2WAS, Ht8WK = Height at 8WAS, SC = Stand Count Prior to harvest, PN/plant = Pod number per plant, PY/plant = Pod yield per plant, SY/plant = Seed yield per plant, 100wt = 100 seeds weight, SP= Shelling Percentage, PW = Pod width, PL = Pod length, SW = Seed width, SL = Seed Length, SY/ha = Seed yield/ha.

It was concluded from this investigation that considerable amount of variation exists among the twelve bambara groundnut accession for yield and yield components. High heritability and genetic advance recorded for length and width of pods, seed length and width clearly indicates that genetic improvement in bambara groundnut could be possible. However, moderate heritability for seed yield/ha-^{1} suggests that considerable limitations for improvement in yield will be encountered.

Table 4: Yearly mean, range, genotypic and phenotypic coefficient of variations, estimates of broad sense heritability (H_B)and genetic advance (GA) of seed yield and related characters evaluated in 2004 (Y_1) and 2005 (Y_2) at Mubi.

Characters		Mean	Range	Genotypic Coefficient Variation	Phenotypic Coefficient Variation	Heritability (%)	GA (%)
Plant Emergence	Y_1						
	Y_2	45.36	30.0-52.7	13.74	21.99	59.2	13.8
		52.42	41.3-59.7	12.54	14.35	74.5	26.4
Emergence %	Y_1						
	Y_2	70.71	46.9-82.3	13.86	21.85	40.8	13.9
		81.69	72.4-88.6	12.54	14.87	71.2	24.4
Height at 8WAS	Y_1						
	Y_2	14.69	12.3-16.8	8.90	11.89	34.9	6.8
		15.10	12.3-16.9	8.14	10.04	54.2	10.1
Stand count	Y_1						
	Y_2	45.00	22.7-53.7	18.69	24.54	58.6	19.0
		51.75	41.3-58.7	11.80	13.72	74.3	24.3
Pods/plant	Y_1						
	Y_2	45.99	40.0-64.8	20.43	24.72	78.8	19.1
		55.39	36.0-78.4	21.53	24.81	75.1	16.4
Pod yield/plant	Y_1						
	Y_2	61.84	41.3-88.5	27.05	20.58	69.8	16.2
		51.82	45.5-85.6	20.85	17.52	69.1	16.3
Seed yield/plant	Y_1						
	Y_2	38.65	22.9-53.1	16.47	19.36	72.8	15.1
		39.34	30.4-52.9	19.42	29.38	70.1	22.5
100 seed wt	Y_1						
	Y_2	83.46	55.6-107	24.91	35.57	92.1	12.4
		86.19	54.5-139.5	24.01	25.73	94.8	13.4
Shelling %	Y_1						
	Y_2	66.10	59.9-70.6	4.98	6.38	61.2	5.0
		69.72	63.3-74.6	5.88	6.38	69.8	4.2
Pod width	Y_1						
	Y_2	1.38	1.11-1.64	12.55	42.55	100	18.5
		1.39	1.11-1.66	10.53	12.58	100	14.9
Pod length	Y_1						
	Y_2	1.87	1.52-2.30	15.12	15.21	100	19.5
		1.88	1.54-2.31	25.56	25.59	100	16.2
Seed width	Y_1						
	Y_2	1.06	0.93-1.26	2.68	2.85	85.2	6.6
		1.08	0.98-1.26	2.61	2.82	87.9	5.9
Seed length	Y_1						
	Y_2	1.29	1.13-1.58	10.96	10.97	100	14.8
		1.32	1.17-1.50	10.96	10.96	96	17.8
Seed yield/ha							
	Y_1	2040.6	1.40-2.96	19.60	38.75	54.8	19.7
	Y_2	2165.8	1.75-2.45	19.72	27.87	52.4	19.9

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Appendix 1: Maximum and Minimum Temperatures, rainfall, relative humidity and sunshine hours during 2004 and 2005 wet seasons'

Month	Days	Max.Temp(ºC)	Min.Temp(ºC)	Rainfall(mm)	Relative Humidity(%)	Sunshine Hours
				2004		
April	1-10	39	22	19	86	4.3
	11-20	37	25	4.3	61	6.3
	21-30	35	22	29.3	67	5.2
May	1-10	34	23	29.6	64	9.1
	11-20	36	19	11.6	69	5.3
	21-30	37	18	50.7	78	4.3
June	1-10	35	19	39.7	69	3.5
	11-20	36	18	21.5	80	5.2
	21-30	34	17	35.4	76	5.0
July	1-10	33	18	39.5	75	4.8
	11-20	28	17	46.5	87	4.6
	21-30	32	18	188.7	88	3.4
August	1-10	28	17	101	89	3.7
	11-20	29	18	65.3	88	4.2
	21-30	30	17	69.6	89	6.7
Sept	1-10	29	18	60.2	87	5.3
	11-20	30	19	64.8	88	6.2
	21-30	31	18	21.5	89	6.6
Oct	1-10	30	17	41	88	5.6
	11-20	31	18	60	90	6.4
	21-30	32	19	32..6	89	7.5
Nov	1-10	33	18	2.8	88	7.3
	11-20	32	19	2.3	89	6.7
	21-30	30	18	0.0	90	6.5
				2005		
April	1-10	36	22	36.5	86	2.2
	11-20	37	21	8.8	81	6.2
	21-30	36	20	1.8	90	5.4
May	1-10	37	22	54.8	89	3.4
	11-20	36	23	20	90	5.1
	21-30	37	20	0.5	89	7.6
June	1-10	36.5	21.4	60.4	89	6.1
	11-20	36.4	20.5	38.5	89.2	6.0
	21-30	31.2	19	55.8	90	6.2
July	1-10	29.5	18.5	33	89	3.1
	11-20	29.2	19.5	90.5	89.3	5.0
	21-30	30	18.2	81.2	89.4	4.2
August	1-10	30	18.1	59	88.3	3.1
	11-20	30.2	18	20.7	89	3.1
	21-30	30	18.2	63.5	89.2	
Sept	1-10	30.2	18.2	138.5	88	3.1
	11-20	30.4	18.1	64	87	4.0
	21-30	29.4	18.2	51.5	89	5.1
Oct	1-10	30	18	27.4	88	6.0
	11-20	31.1	15.4	14.5	89	5.1
	21-30	32	15	0.0	88	8.1
Nov	1-10	31	17	0.0	87	9.1
	11-20	32.2	18	0.0	86	10.1
	21-30	31.5	16	0.0	87	5.1

Appendix:2

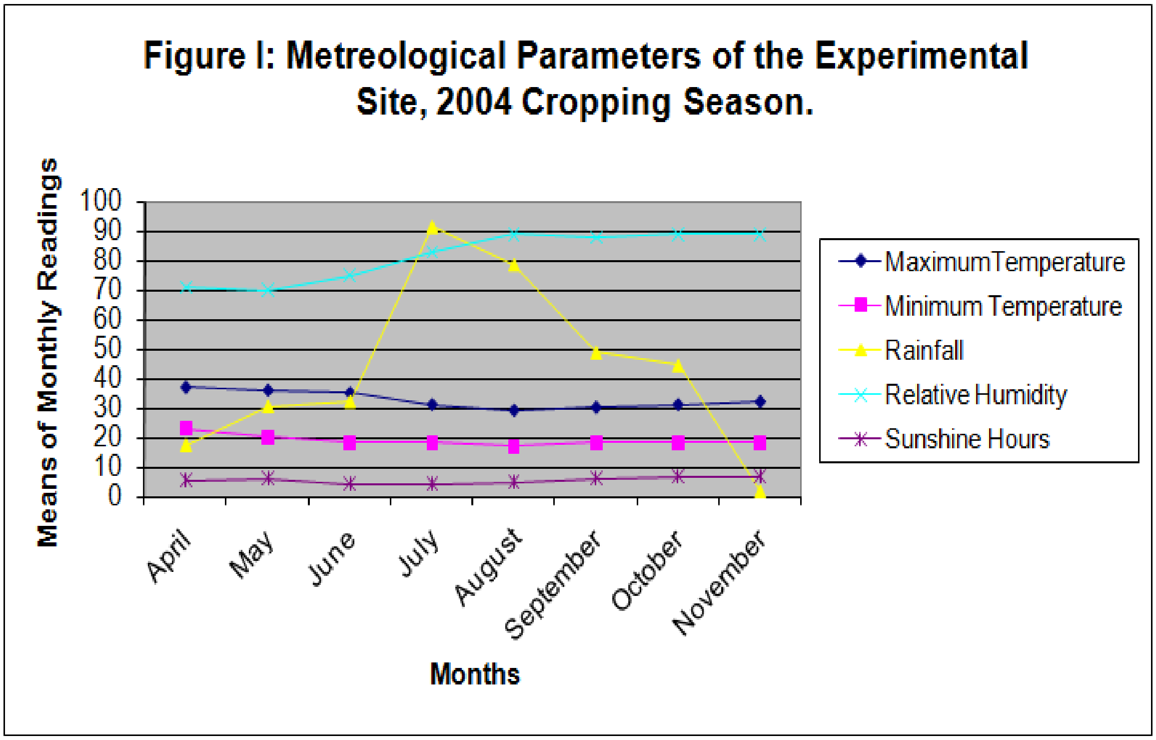
Figure I: Metreological Parameters of the Experimental Site, 2004 Cropping Season.
Means of Monthly Readings
100
90
80
70
60
50
40
30
20
10
0
April
May
June
July
August
September
October
November
Months
MaximumTemperature
Minimum Temperature
Rainfall
Relative Humidity
Sunshine Hours

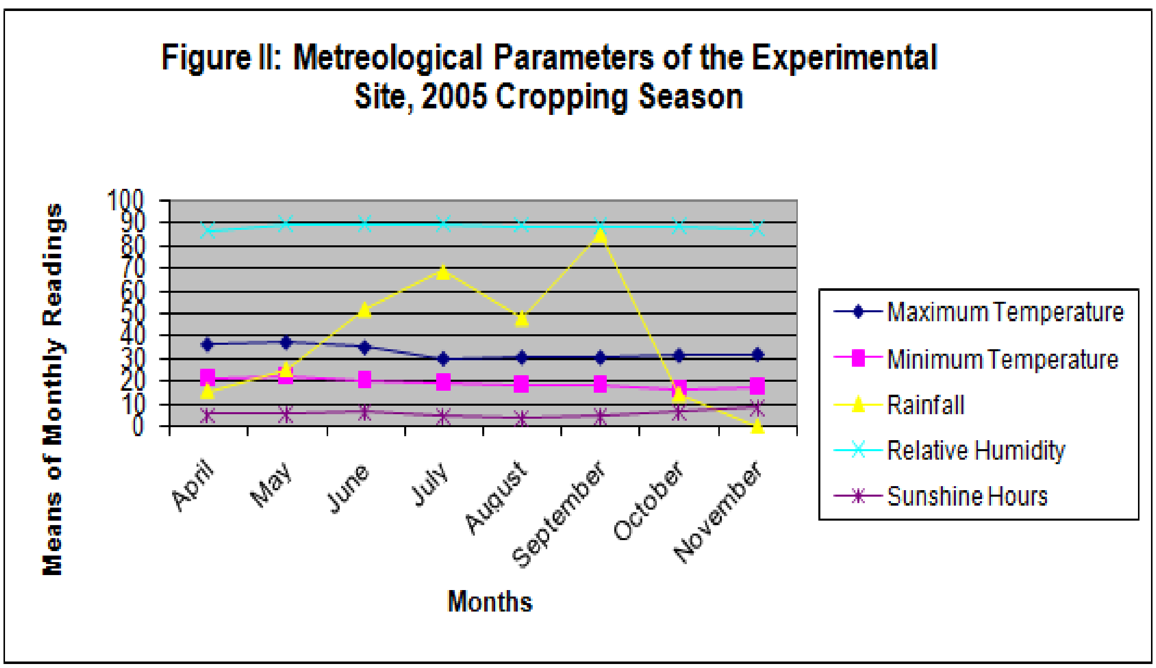
Figure II: Metreological Parameters of the Experimental Site, 2005 Cropping Season
Means of Monthly Readings
100
90
80
70
60
50
40
30
20
10
0
April
May
June
July
August
September
October
November
Months
Maximum Temperature
Minimum Temperature
Rainfall
Relative Humidity
Sunshine Hours