I J T A
© Serials Publications
National Academy of Agricultural Science (NAAS)
Rating : 3.03

Genetic Studies of Yield and Yield Component of Niger (*Guizotia Abyssinica* Cass.) in Rainfed Condition of Western Plateau of Jharkhand

Ekhlaque Ahmad[*], *Munish Kumar Singh, A. Paul, A. M. Ansari and D. N. Singh*

Abstract: *A study was undertaken to obtain the information on extent of genetic variability and inter-relationship of seed yield and associated characters under rainfed upland condition in niger and it was carried out at Zonal Research Station (*Birsa Agricultural University*), Chianki during* kharif *2012-13. The experimental material was constituted with eleven diverse niger genotypes and planted in the randomized block design with three replications. The analysis of variance revealed that there is a significant difference among the genotypes for all. The traits which indicated the presence of sufficient variability among the genotypes for various traits studied. High estimate of genotypic and phenotypic coefficient of variation were observed for grain yield per plant, number of capitulum per plant, secondary branches per plant and number of seeds per capitulum indicated wider genetic variation for these traits. High value of heritability coupled with high expected genetic advance as per cent of mean were observed for the characters* viz.*, 1000-seed weight, number of capitulum per plant and number of seeds per capitulum indicated that selection may be effective for these characters. The results of correlation studies indicated that genotypic correlation coefficients were higher in magnitude than their corresponding phenotypic correlation coefficients for most of the traits. Grain yield per plant was found positively and significantly associated with number of primary branches per plant, number of secondary branches per plant, number of capitulum per plant and number of seeds per capitulum at both genotypic and phenotypic levels indicating that these traits were main yield attributing traits. Plant height, number of capitulum per plant and 1000-seed weight exerted high positive direct effect on seed yield. For maximizing the grain yield per plant emphasis should be given in selection of characters such as number of branches per plant, number of capitulum per plant, number of seeds per capitulum, and 1000-seed weight for further improvement of niger crop.*

Key words: *Niger, GCV, PCV, heritability, genetic advance, correlation and path analysis*

INTRODUCTION

Niger (*Guizotia abyssinica* Cass.) belongs to the family Asteraceae and cultivated in Indian subcontinent and East African Countries (Getinet and Sharma, 1996). India ranks first in area, production and export of niger in the world with an earning of more than Rs.100 crores as foreign exchange (Bisen *et al*.2015) but it has very low productivity (329 kg/ha). In Jharkhand, this oilseed crop is an important component of tribal agriculture and considered as lifeline for nutritional security but cultivated in poor and neglected soil under rainfed conditions. Although it is considered as minor oilseed crop and important in terms of its quality oil (40%) content. It's importance is well known in human nutrition as it contains high amount of the essential unsaturated fatty acid, linoleic acid (85%); high amount of cysteine, and has the ability to reduce blood cholesterol (Ramdan, 2012). The oil is considered good for health which is pale yellow with nutty taste and a pleasant odour and can be used as a substitute for olive oil provided it has good keeping quality and self-life. The seed itself is edible with no anti-nutritional factor but contains more crude fiber than most of the oilseed meal which is of high quality and is mainly used

* Zonal Research Station *(Birsa Agricultural University)*, Chianki Palamau, 822102*, Email: ekhlaque.bau@gmail.com*

for culinary purpose, manufacture of cosmetics, soaps, paints, lubricating and lighting. Oilseed meal is used as cattle and poultry feed. The oil from the seed is used to treat burns and in the treatment of scabies. The press cake from oil extraction is used for livestock feed. Variability exists for morphological characters (Pradhan *et al.,* 1995); however these characters are not discrete and hence complicate the niger improvement programs. The study of amount of such genetic variability including the important economic traits in Niger can be achieved through mass selection (Panda and Sial, 2012). The information on genetic variability and character association between yield and its components are of utmost importance to initiate the breeding programme to evolve high yielding varieties. Further direct selection for complex traits like seed yield is not effective. Knowledge of association of the simply inherited traits, which are less influenced by environment, is required to have sound selection criteria.

The present study was aimed for development of useful selection scheme on the basis of extent of genetic variability of seed yield and its components in a set of 11 diverse genotypes and their manipulations through hybridization programme.

MATERIALS AND METHODS

The study was laid out in a randomized complete block design with three replications at experimental area of Zonal Research Station (latitude 24.25°N and longitude 84.04° with an altitude of 228.6 m from MSL), Chianki, Palamau of the Birsa agricultural University during *Kharif* 2012 under rainfed condition. The experimental material was comprised of eleven promising genotypes along with one national check (Puja) and was sown in ten rows of 5.0 m length with the inter row spacing of 30 cm and 15cm between plants of each entries. The crop was raised under recommended package of practices and all prophylactic protection measures were also undertaken. Ten randomly selected plants were tagged for recording of data on plot basis for nine important characters *viz*., days to 50% days to maturity, plant height, number of primary branches, number of secondary branches, number of capitula per plant, number of seed per capitulum, 1000-seed weight (g) and grain yield (q/ha). Analysis of variance was performed following the standard procedures described by Singh and Chaudhury, 1998. The phenotypic and genotype coefficients of variability were computed according to the method suggested by Burton (1952). Heritability (broad sense) and genetic advance were estimated as per Johnson *et al.* (1955). Correlation coefficients were computed as suggested by Robinson *et al.* (1951) and Path coefficient analysis was carried out with following the method of Dewey and Lu (1959).

Results and Discussion

The analysis of variance revealed significant differences among the genotypes for all the nine Characters (table 1) studied. Mean performance of the yield and its attributing characters of genotypes has been indicated in table 2. The days to 50% flowering ranged from 53.00-59.00, days to maturity ranged from 105.00 to 113.00, plant height ranged from 49.13-67.80, primary branches per plant ranged from 4.60-5.80 whereas secondary branches per plant ranged from 3.46-5.46, no of capitulum per plant ranged from 30.06-46.60, no of seed per capitulum ranged from 23.73-32.06, thousand seed weight ranged from 3.26-3.96 whereas grain yield ranged from 373.24-723.12 kg/ha. Panda and Sial (2012) also reported the wide range of variation for most of the characters studied. Estimates of genetic parameters indicated that GCV (genotypic coefficient of variation) was found to be highest for grain yield per hectare followed by number of capitulum per plant and number of branches per plant (table 3). Similar trend were observed for phenotypic coefficient of variation (PCV). Close relationship between GCV and PCV was found in all the characters and PCV values were slightly greater than GCV, revealing very little influence of environment for their expression. High GCV for grain yield per plant and number of seeds per capitulum per plant was also reported by Mishra *et al.* (1992), Pradhan *et al.* (1995), Ahmad *et al.* (2003), Panda and Sial (2012), Patil *et al.* (2013) and Jagtap *et al.* (2014). Heritability combined with genetic advance plays a vital role in deciding the suitability and strategies for selection of a particular character (Ubi *et al*., 2001). The traits under study exhibited high broad sense heritability (0.39% to 0.81%), and

Table 1
Analysis of variance for nine quantitative characters in Niger genotypes

Source of variation	*d.f.*	*Mean Sum of squares*								
		Days to 50% flowering	*Days to maturity*	*Plant height (cm)*	*No. of primary branches*	*No. of secondary branches*	*No. of capitulum per plant*	*No. of seeds per capitulum*	*1000-seed weight (g)*	*Yield per plant (g)*
Replications	2	1.727	0.848	15.913	0.603	0.371	5.676	4.779	0.051	6677.652
Genotypes	10	12.533**	14.157**	105.037**	0.496**	0.092**	77.787**	26.181**	0.144**	35998.842**
Error	20	2.861	4.248	18.366	0.168	0.197	7.927	5.677	0.016	2554.397

*,** Significant at 5% and 1% levels respectively.

Table 2
Mean values for different quantitative characters Niger genotypes

S. No	*Parameters*	*Days to 50% flowering*	*Days to maturity*	*Plant height (cm)*	*Primary branches per plan*	*Sec. branches per plant*	*No. of capitulum per plant*	*No. of seeds per capitulum*	*1000-seed weight (g)*	*Yield (kg/ ha)*
1	BN-1	58.0000	106.6667	57.6000	4.6000	4.6667	35.4667	26.3000	3.4933	560.44
2	BN-2	53.6667	108.0000	61.3333	4.9333	4.7333	35.3333	24.2667	3.7033	577.71
3	BN-3	55.6667	109.6667	56.3333	5.5667	5.4000	42.9333	32.0667	3.4567	644.63
4	Puja	58.0000	109.0000	55.0000	4.8000	4.6667	35.5333	25.1333	3.2967	451.39
5	IVT-11-10	56.3333	107.3333	67.8000	4.8667	5.1667	36.4667	31.2000	3.3733	545.82
6	IGP-76	53.6667	105.0000	66.4000	5.5333	5.4000	36.0000	23.7333	3.4567	540.88
7	IGPN-9001	53.0000	108.0000	55.0000	5.8000	5.4667	46.6000	29.3333	3.2633	723.12
8	DNC-08-09	55.6667	110.0000	54.4667	4.6000	4.7333	31.3333	24.8667	3.4200	417.46
9	JNS-508	59.6667	113.0000	49.1333	4.8667	4.8000	30.6000	24.3333	3.9667	456.38
10	JNS-503	56.3333	110.6667	52.6000	5.2667	4.8000	32.4667	24.4667	3.4933	373.24
11	JNS-505	56.0000	110.0000	63.6000	5.0000	3.4667	30.0667	27.0000	3.8200	391.72
	Mean	56.0000	108.8485	58.1151	5.0758	4.8455	35.7091	26.6091	3.5221	516.62
	S.Em.	0.9765	1.1900	2.4743	0.2367	0.2564	1.6255	1.3757	0.0232	29.1799
	C.D. at 5%	2.8806	3.5106	7.2992	0.6982	0.7562	4.7953	4.0583	0.0683	86.0801
	C.V.%	3.0202	1.8936	7.3744	8.0767	9.1636	7.8845	8.9549	1.1391	9.7830

it was coupled with high genetic gain (index for selection criteria) for grain yield per hectare (37.97%) followed by number of capitula per plant (24.05%), number of secondary branches per plant (15.62%) and number of seed per capitulum (14.96%) while other traits exhibited moderate to low genetic gain. Heritable variation is useful for permanent genetic improvement and it has been reported that high values of genetic advance are indicative of additive gene action whereas low values are indicative of non-additive gene action. Johnson *et al.* (1955) have also suggested that characters with high heritability coupled with high genetic advance would respond better to selection than those with high heritability and low genetic advance. Nayakar (1976), Goyal and Kumar (1985), Ahmad *et al.* (2003), Patil (2003) and Patil *et al.* (2013) also observed high heritability and genetic advance for these traits.

The results on correlation coefficients revealed that both genotypic and phenotypic correlations followed the same trend but the genotypic correlations were generally higher than the phenotypic correlations coefficients for all the traits under study, indicating that the phenotypic expression of correlations is reduced under the influence of environment (table 4). This is not unusual

Table 3
The estimates of genotypic and phenotypic variance and other genetic parameters for nine traits in Niger genotypes

Characters	*Range*	*Mean*	*GCV*	*PCV*	*h² %*	*G.A. % of mean*
Days to 50% flowering	53.00 - 59.66	56.00	3.21	4.40	0.53	4.81
Days to maturity	105.00 - 113.00	108.85	1.67	2.52	0.44	2.27
Plant height (cm)	49.13 - 67.80	58.12	9.25	11.83	0.61	14.90
Primary branches per plan	5.80 - 4.60	5.08	6.51	10.38	0.39	8.43
Sec. branches per plant	3.46 - 5.47	4.85	10.20	13.71	0.55	15.62
No. of capitulum per plant	30.06 - 46.60	35.71	13.51	15.65	0.75	24.05
No. of Seed per capitulum	23.73 - 32.07	26.61	9.82	13.29	0.55	14.96
1000-seed weight (g)	3.26 - 3.97	3.52	6.18	6.29	0.97	12.53
Grain Yield (Kg/ha)	373.24 - 723.12	516.62	20.44	22.66	0.81	37.97

Table 4
Genotypic and phenotypic correlation between yield and other traits of Niger under study

Characters		*Days to 50% flowering*	*Days to maturity*	*Plant height (cm)*	*No. of primary branches*	*No. of secondary branches*	*No. of capitulum per plant*	*No. of seeds per capitulum*	*1000-seed weight (g)*	*Yield per plant (g)*
Days to 50% flowering	P	1.0000	0.6834	-0.5292	-0.8978	-0.4854	-0.6732	-0.1308	0.4154	-0.6220*
	G	1.0000	0.4090*	-0.3615*	-0.3776*	-0.1762	-0.3251	-0.1458	0.2972	-0.3572*
Days to maturity	P		1.0000	-1.0068*	-0.2741	-0.4816	-0.5081*	-0.0276	0.6366	-0.5819
	G		1.0000	-0.4301*	-0.1239	-0.2205	-0.2679*	-0.1642	0.4223	-0.3636*
Plant height (cm)	P			1.0000	-0.0923	-0.1498	0.0725	0.1693**	-0.1253	0.1329
	G			1.0000	0.2088	0.0807	-0.0104	0.3028**	-0.1201	0.1847
No. of primary branches	P				1.0000	0.4881**	0.8799*	0.2980*	-0.3356	0.6288**
	G				1.0000	0.5883**	0.5326**	0.3885*	-0.2048	0.4931**
No. of secondary branches	P					1.0000	0.8331**	0.3486	-0.6283	0.7388**
	G					1.0000	0.5416**	0.2599	-0.4555	0.5969**
No. of capitulum per plant	P						1.0000	0.7517**	-0.6475**	0.9620**
	G						1.0000	0.5119**	-0.5622**	0.8369**
No. of seeds per capitulum	P							1.0000	-0.4001	0.5955**
	G							1.0000	-0.2975	0.5344**
1000-seed weight (g)	P								1.0000	-0.4024*
	G								1.0000	-0.3618*

*,**: Significant at 5% and 1% levels respectively

Table 5
Phenotypic (P) and genotypic (G) path coefficients among seed yield and its components in Niger

Characters		*Days to 50% flowering*	*Days to maturity*	*Plant height (cm)*	*No. of primary branches*	*No. of secondary branches*	*No. of capitulum per plant*	*No. of seeds per capitulum*	*1000-seed weight (g)*	*rg with Yield per plant (g)*
Days to 50% flowering	P	1.3998	0.9566	-0.7408	-1.2567	-0.6794	-0.9423	-0.1830	0.5815	-0.6220*
	G	-0.0951	-0.0389	0.0344	0.0359	0.0168	0.0309	0.0139	-0.0283	-0.3572*
Days to maturity	P	-0.5034	-0.7366	0.7417	0.2019	0.3547	0.3743	0.0204	-0.4690	-0.5819
	G	-0.0527	-0.1290	0.0555	0.0160	0.0284	0.0346	0.0212	-0.0545	-0.3636*
Plant height (cm)	P	-0.1404	-0.2671	0.2652	-0.0245	-0.0397	0.0192	0.0449	-0.0332	0.1329
	G	-0.0434	-0.0516	0.1199	0.0250	0.0097	-0.0012	0.0363	-0.0144	0.1847
No. of primary branches	P	-0.8032	-0.2452	-0.0825	0.8947	0.4367	0.7872	0.2666	-0.3003	0.6288**
	G	0.0774	0.0254	-0.0428	-0.2050	-0.1206	-0.1092	-0.0796	0.0420	0.4931**
No. of secondary branches	P	-0.0756	-0.0750	-0.0233	0.0761	0.1558	0.1298	0.0543	-0.0979	0.7388**
	G	-0.0600	-0.0751	0.0275	0.2004	0.3407	0.1845	0.0885	-0.1552	0.5969**
No. of capitulum per plant	P	-0.7597	-0.5733	0.0818	0.9929	0.9401	1.1284	0.8483	-0.7307	0.9620**
	G	-0.2687	-0.2214	-0.0086	0.4402	0.4476	0.8265	0.4231	-0.4646	0.8369**
No. of seeds per capitulum	P	0.0307	0.0065	-0.0397	-0.0699	-0.0818	-0.1764	-0.2346	0.0939	0.5955**
	G	-0.0199	-0.0224	0.0413	0.0529	0.0354	0.0697	0.1362	-0.0405	0.5344**
1000-seed weight (g)	P	0.2299	0.3523	-0.0694	-0.1857	-0.3477	-0.3583	-0.2214	0.5533	-0.4024*
	G	0.1051	0.1494	-0.0425	-0.0724	-0.1611	-0.1989	-0.1052	0.3537	-0.3618*

*,**: Significant at 5% and 1% levels respectively. Phenotypic residual effect : 0.0775, Genotypic residual effect : 0.3977

as has been reported by many earlier worker *viz.* Ram and Trivedi (1988), Mathur and Gupta (1995), Borole and Patil (1997) and Ahmad *et al.* (2003).

It was observed that grain yield per plant had positive and significant correlation with number of primary branches per plant (rg = 0.6288 and rp = 0.4931), number of secondary branches per plant (rg = 0.7388 and rp = 0.5969), number of capitulum per plant (rg = 0.9620 and rp = 0.8369), number of seeds per capitulum (rg = 0.5955 and rp = 0.5344) at both genotypic and phenotypic levels while days to 50% flowering, days to maturity and plant height were negatively correlated. 1000-seed weight was negatively and significantly correlated with number of capitulum per plant (rg = 0.6475 and rp = 0.5622) at both genotypic and phenotypic level.

Number of seeds per capitulum was positively and significantly correlated with plant height (rg = 0.1693 and rp = 0.30282), number of primary branches per plant (rg = 0.2980 and rp = 0.3885) and number of capitulum per plant (rg = 0.7517 and rp = 0.5119) at both genotypic and phenotypic level. Number of capitulum per plant showed positive significant association with number of primary branches per plant (rg = 0.8799 and rp = 0.5356) and number of secondary branches per plant (rg = 0.8331 and rp = 0.5416). Number of secondary branches per plant was positive significant correlation with number of primary branches per plant (rg = 0.4881 and rp = 0.5883). The strong positive correlations of number of primary branches per plant, number of secondary branches per plant, number of capitulum per plant, number of seeds per capitulum, capitulum diameter and 1000-seed weight with grain yield per plant indicated that these characters might be utilized as selection criteria for improving grain yield in niger crop. The observed positive

correlation of grain yield with various traits was supported by earlier workers *viz*., Abraham and Gupta (1989), Pradhan, *et al*. (1995) and Panda and Sial (2012), for number of primary & secondary branches per plant and capitulum per plant; Patil (2003), Patil *et al.* (2013) and Jagtap *et al.* (2014 for seeds per capitulum and 1000-seed weight; Sahu and Patnaik (1981), Goyal and Kumar (1985), Patel *et al.*(1993a) and Ahmad *et al*. (2003) for number of capitulum per plant.

With a view to know the direct and indirect effects of these traits seed yield correlations were further partitioned into direct and indirect effects through path coefficient analysis. The residual effect of 0.0775 indicates that some more traits related to seed yield need to be included (table 5). The results revealed that number of capitulum per plant exerted highest positive direct effect on seed yield followed by 1000- seed weight. These results are in conformity with the reports of Goyal and Kumar (1985), Patel *et al. (*1993b), Ram and Trivedi (1993) and Patil *et al.* 2013). The characters *viz*., Plant height, primary branches per plant and number of secondary branches per plant had moderate positive direct effects on seed yield whereas number of seeds per capitulum diameter had low positive direct effect. On the other hand the characters days to maturity and plant height had negative direct effects on seed yield. These results are in conformity with the reports of Goyal and Kumar (1985), Patel *et al. (*1993b), Ram and Trivedi (1993) and Patil *et al*. (2013). These characters associated with grain yield per hectare were due to high positive direct and indirect effect therefore emphasis may be given in yield improvement by incorporation the findings of the preceding results and discussion.

CONCLUSION

The present investigation is concluded that there is sufficient variability present among genotypes studied. On the basis of results as summarized above, it is concluded that the great deal of variability for the important characters studied even in highly selected lines. High heritability with high genetic advance for number of number of seeds per capitulum and number of capitulum per plant had strong and positive correlation and direct effect to grain yield. These characters can be utilized as selection criteria for the development of high yielding niger varieties.

References

Ahmad, E., Ram, S., Kerketta, V. and Singh, D. N. 2003. Genetic association, heritability and genetic advance in niger (*Guizotia abyssinica* Cass). *J. Res.(BAU),* **15**(2):251-54.

Bisen, R., Pandey, A. K., Jain, S. Sahu, R., Sharma, S. and Ranganatha, A.R.G.2015. Genetic analysis using variability, correlation and path analysis in niger (*Guizotia abyssinica* Cass). In: IOSR extended summaries: National Seminar on Strategic intervention to enhance oilseeds production in India. Organiged by IOSR, Hyderabad from Feb. 19-21, 2015 at ICAR-DRMR, Bharatpur. Pp. 123-125.

Borole, R. D, and Patil, H.S. (1997) Genetic variability, correlation and path analysis in niger. *Journal of Oilseeds Research.* 20(3):40-43

Burton, G. W. (1952) Quantitative inheritance in grasses. *Proc.6th Int. Grassland Cong*., 1: 227-287.

Dewey, D. R. and Lu, K. H. (1959) A correlation and path coefficient analysis of components of wheat grass seed production. *Agron. J*., **51**: 515-518.

Getinet, A. and Sharma S.M. (1996). Niger [*Guizotia abyssinica* (L.f.) Cass.]: Promoting the

conservation and use of underutilized and neglected crops 5International Plant Genetic Resources Institute, Rome, 59 p.

Goyal, S.N. and Kumar, S. (1985). Correlation and path analysis in niger. *Journal of Oilseeds Research*, 2: 34-38.

Jagtap, P. K., Sandipan, P. B., Patel, K. M and Patel, M. C. (2014) Trait association analysis for yield and yield attributing traits in niger Germplasm. *National Symposium on Crop Improvement for Inclusive Sustainable Development, Nov. 7-9, 2014, PAU, Ludhiana. Pp. 891.*

Lush, J.L. (1949) Heritability quantitative characters in farm animals. *Proc. 8th Int. Cong. Genet. (1948)*:356

Johnson, H. W., Robinson, H. F and Comstock, R. E. (1955) Estimates of genetic and environmental variability in Soyabean. *Agron. J*., 47: 314-318.

Mathur, R.K. and. Gupta, S.C. (1995) Indirect selection for grains yield in niger (*Guizotia abyssinica* Cass). *Crop Improvement.* 9(1):163-64

Misra, A., Sarker, J.M. and Basu, N.C. (1992) Genetic variability of certain quantitative

characters in niger (*Guizotia abyssinic*a Cass). *Environ. and Ecology* 10:511-513.

Nayakar. N.Y. (1976) Genetic variability and heritability for six quantitative characters in niger (*Guizotia abyssinica* Cass). *Mysore J. Agric. Sci.* 10:553-558.

Panda, S. and Sial, P. (2012) Assessment of existing genetic variability and yield component

analysis in Niger (*Guizotia Abyssinica* Cass.). *Indian Journal of Innovations Development.* 1(7):511-514

Patel, O.P., R.K. Mishra and R.K. Yadav. 1993a. Variability and correlation in niger (*Guizotia abyssinica* Cass). *Adv. Plant Sci*. 6:186-190.

Patil, H. E., Mali, S. R., Giri A. R. and Thawari, S. B. (2013) Genetic improvement in niger (*Guizotia abyssinica* Cass.) by using study of variability, correlation and path analysis. *International Journal of Agricultural Sciences.*9:671-73.

Patel, O.P., Mishra, R.K. and Yadav, R.K. (1993). Path coefficient analysis in niger. *Adv.Plant Sci.* 6:290-292.

Patil, H.S. 2003. Nature of variability, association and path analysis in niger. *Crop Improvement.* 30(20): 212-215.

Pradhan, K., Mishra, R. C. and. Paikary, R. K. (1995) Genetic variability and character

association in niger. *Indian Journal of Genetics and Plant Breeding* , 55 (4): 457-459

Ram, S. and Trivedi, H.B.P. (1988) Association of morphological and physiological characters with seed yield in niger (*Guizotia abyssinica* Cass.). *Symposium for increasing Oilseeds production in Eastern India.* (May, 12-14):62

Ram, S. and Trivedi,H.B.P. (1993). Path coefficient analysis in niger (*Guizotia abyssinica*

Cass). *Oil Crops Newsl*. 10:67-68.

Ramdan, M. F. (2012) Functional properties, nutritional value and industrial applications of niger oilseeds (*Guizotia abyssinica* Cass.). *Critical reviews in food science and nutrition.* 52:1-8.

Singh, R. K. and Chaudhury, B. D. **(**1985). *Biometrical methods in quantitative genetic analysis*. Kalyani Publishers, New Delhi.

Ubi, E. B., Mignouna, H. and Obigbesan, G. (2001). Segregation for seed weight, pod length and days to flowering following cowpea cross. *African Crop Science Journal*, **9**(3): 463-470.