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Phenotypic Stability of Flowering and other Quantitative Characters in Forage Cowpea (*Vigna Unguiculata* (L.) Walp

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The varieties of forage cowpea were evaluated for stability parameters with respect to flower initiation, main stem length, number of branches and leaf areas in eight environments. The varieties included in the study were: FOS 1, HFC 42-1, GFC 2, GFC 3, GFC 4, UPC 9020, EC 4216, C 152, C1 and 82-1-B Presence of genotype x environment interaction was observed. The linear component appeared to account for most of the interactions present. Variety EC 4216 was most stable for flowering trait, C 152 for main stem length, GFC 4 for number of branches and 82-1-B for leaf area.

The ability of a variety to perform well over a wide range of environmental conditions has long been a desired quality. The stability of performance or alternatively a minimum of interaction with environments is genetic in nature. The preliminary evaluation and identification of stable genotypes could be very helpful in the development of varieties with stable performance. Various methods have been developed which could be used to provide estimates of genotype x environment interactions (Finly and Wilkinson, 1963; Eberhart and Russell, 1966; Perkinds and Jinks, 1968). A large amount of information is available on the study of phenotypic stability of different genotypes in various plant species by using these models. However, information on fodder cowpea is limited (Paroda *et al.*, 1973; Malik *et. al*, 1973) Therefore, in the present investigation the data on certain green fodder components of ten varieties of cowpea grown in eight different environments have been analysed to collect information on the genotype x environment interactions.

MATERIAL AND METHODS

The experimental material consisted of ten genotypes of fodder cowpea. These were : FOS 1, HFC 42-1, GFC 2, GFC 3, GFC 4, UPC 9020, EC 4216, C 152, C1 and 82-1-B. These genotypes were grown in eight different environments. These environments were created by taking eight different dates of sowing which were : 14 and 30 July 15 and 31 August, 16 September, 1 and 16 October and 1 November. These will be referred as different environments in this paper.

The experiment was sown in a four replicated randomized block design by taking a single row plot of 5 meter in length. Seed material was dibbled at a distance of 20 cm within row and 50 cm between rows. Separate sowings were done for each environment. Observations were recorded on ten competitive plants on days to flower initiation, main stem length (cm), number of branches (no) and leaf area (cm^2). Statistical analysis

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was conducted according to the method proposed by Eberhart and Russell (1966).

RESULTS AND DISCUSSION

The pooled analysis of variance presented in Table 1 showed that the mean differences between genotypes and environments were highly significant when tested against pooled deviation, pooled error and genotype x environment interactions, suggesting differences between the genotypes as well as between environments. The mean squares were significant for genotype x environment interactions (linear) for all the characters indicating that linear components accounted for the major portion of these interactions. The pooled deviation was also significant for all the characters under study suggesting that the genotypes differed with respect to their stability for the four characters that is days to flower initiation, main stem length, number of branchas and leaf area.

The stability parameters ($\bar{x}$ b., $\bar{s}^2d$) of all the genotypes worked out for the quantitative characters days to flower initiation, main stem length, number of primary branches and leaf area are presented in Table 2. Considering days to flower initiation an examination of the stability parameters b and $\bar{s}^2d$ of the individual genotypes showed that both b and $\bar{s}^2d$ for the varieties GFC 4 and C 152 were significant, indicating that both linear and non linear components accounted for total genotype x environments. However, in the remaining eight genotypes only non linear regression accounted for the genotype x environment interactions. Considering the three parameters simultenously variety C 1 was earliest in flowering, below average in response and stable The varieties like GFC 2, GFC 3 and GFC 4 were late and could be considered above average in response and most unstable for this trait except GFC4 which was stable. EC 4216 was medium early, below average in response and the most stable genotype.

The mean values for main stem length were significantly more than the average for the varieties GFC 3, GFC 4 and GFC 2. Their b values were also high and significant for GFC 3 and GFC 4. $\bar{s}^2d$ values for these three varieties were also very high and significant, suggesting that both linear and non linear components of genotype x environment interactions were involved. They possessed high stability values and were sensitive to environmental changes. Variety C 152 was the most stable under poor environmental conditions. Popular forage varieties like HFC 42-1 and EC 4216 were below average in performance, poor in response and posspssed average stability.

Estimates of $\bar{x}$ for the character number of branches were significantly higher than the average for the varieties GFC 2, GFC 3 and GFC 4. The b values for all the varieties were non-signi ficant suggesting the absence of linear component of interactions, Non linear interaction component was present for the varieties C 1 and EC 4216 only. These varieties could be considered as

unstable which is evident from their high S^2d values. Out of these four genotypes GFC 2 and 82-1-B could be considered stable which would give linear response to the improvement in the environmental conditions.

The test of significance for b and S^2d indicated that seven varieties were significant for their b values and six for S^2d, presence of considerable genotype X environment interactions was shown. Genotype C 1 could be considered as the most unstable for the trait leaf area because of its low values of X and high S^2d. GFC 4 could be considered as stable genotypes possessing high performance, b value near 1 and low S^2d value. Since leaf area is an important component of forage yield and quality exploitation of a variety like GFC 4 to get higher fodder yield will be appropriate in all environments while GFC 3 in good environments.

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TABLE I Pooled analysis of variance

Source	d. f.	Days to flower initiation	Main stem length	Number of branches	Leaf area
Genotypes (G)	9	784.88@@++**	19102.89@@++**	3.94@@++**	1935.05@@++**
Environments (ENV)	7	735 20@@++**	6991.00@@++**	3.89@@++**	6966.01@@++**
G x (ENV)	63	60.19**	499.34**	0 23*	479.04**
ENV+(GxENV)	70	112 93++**	1086.16++**	9.59++**	1027.73**
ENV (linear)	1	6146.40++**	48937 39++**	27.25++**	41762.07++**
G x ENv (Dinear)	8	303.10++**	714.76**	1.76++**	2941.53÷+**
Pooled deviation	60	33.59**	344.35**	0.19*	110.78**
Pooled error	240	1.61	18.62	0.13	57.08

@, @@ Significant against G x (ENV) at 5 and 1 per cent respectively.

+, ++ Significant against pooled deviation at 5 and 1 per cent respectively.

*, ** Significant against pooled error at 5 and 1 per cent respectively.

Table II : Stability Parameters of different genotypes for quantitative characters studied

Genotypes	Days to flower initiation			Main stem length			Number of branches			Leaf area		
	$\bar{X}$	b	$\bar{S}^2d$	$\bar{X}$	b	$\bar{S}^2d$	$\bar{X}$	b	$\bar{S}^2d$	$\bar{X}$	b	$\bar{S}^2d$
FOS 1	51.15	1.17	51.95**	69.41	0.63	384.04**	3 58	0.82	0.05	100.64	1.61**	-132.71
HFC 42-1	48.01	0.65	18.77**	71.66	0.92	198 93**	2.65	1.28	0.18	76 83	0.15**	206 82**
GFC 2	69.54	1.20	53.93**	167.22	1.48	449.39**	4.53	1.01	0.15	87.64	0.50**	136.67**
GFC 3	66.81	1.48	50.68**	179.28	1.56*	416.56**	4.24	0.43	0.04	102.63	1.63**	58 15
GFC 4	68.20	1.69**	18.08**	168.47	1.61*	434.91**	4.34	0.62	0.01	108.16	1.10	-106.33
UPC 9020	56.22	1.10	57.99**	78.13	0.66*	431.52**	3.35	0.73	0.16	119.41	1.39*	-200.31*
EC 4216	50.44	0.56	6.35**	64.00	0.49	225.51**	4.01	1.28	0.44**	111.21	1.49**	-191.00*
C 152	50.61	0.40*	13.72**	62.72	0 54	46.60**	3.67	1.70	0.09	98.72	1.06	259.96**
C 1	42.58	0.78	17.79**	67.59	1.01	471.34**	2.39	1.48	0.29**	88.96	1.87**	461.30**
82-1-B	45.08	0.93	41.27**	90.35	0.83	322.74**	3.76	1.03	0 06	69.60	1.09	45.06
Mean	54.87			101 88			3.64			96 18		
C. D. at 5%	6.20			.19.84			0.47			11.25		

*, ** Significant at 5 and 1 percent respectively.