Agricultural Journal 2 (1): 77-81, 2007

Studies on Stability and Interrelationships among Stability Parameters for Fodder Yield in Cowpea (*Vigna unguiculata* [L.] Walp)

Adeniji Olawale Taiwo
Department of Crop Science, Adamawa State University, PMB 25 Mubi, Nigeria

Abstract: Twenty-two early and medium maturing groups of cowpea were evaluated for fodder yield potential in a split plot arrangement randomized complete block design, with three replications during 2005 cropping season in Mubi, Nigeria. The mean fodder yield for the cowpea genotypes across insecticidal environment were used to study the stability of performance, correlation analysis among stability parameters and mean fodder yield. The results indicated variations among stability parameters used. Using the generalized linear model, significant differences ($p<0.05$) were recorded for genotypic effects, insecticidal environment and genotype x environment interaction. Eight groups of stability parameters (i) Fwb_1 and PJb_1 (ii) FWvar and PJvar (iii) P1959 and Wricke (iv) Adj R^2 and R^2, (v) Shukla and Plaisted, (vi) Shukla and Plaisted (vii), and Wricke (viii) Plaisted and Peterson and Wricke were identified through simple correlation coefficient r = 1.00. Representative of each group was selected and used together with fodder yield in an enlarged rank sum method to identify cowpea genotype with the best fodder yield. IT 98K-1111-1, IT 86D-1010, IT 86D-719, IT 93K-452 and IT 97K-503-1 were identified to be of a high fodder yield and stable performance across insecticidal environment.

Key words: *Vigna unguiculata,* fodder yield, intercorrelations, stability parameter, cowpea insecticides

INTRODUCTION

Cowpea production is a predominant occupation in the Northern Guinea and Sudan Savannah of Nigeria representing more than 5% of the total land area of the sub Sahara Africa. Cowpea is cultivated as a second crop after maize in rotation or in intercropping arrangement, which favour forage production[1]. More often, cowpea/millet, cowpea/sorghum intercropping is a dominant[2]. The desirability for fodder yield in cowpea is sequel to the non availability of livestock feeds during the prolong dry season for grazing animals. Dual purpose cowpea genotypes (fodder and grain yield) are either spreading or erect in growth pattern. Several genotypes of cowpea have been developed for fodder yield, yet variation still exists. Farmers in this region harvest fodder at the first sign of drought, usually at the end of the rainy season. The fodder is cut and rolled with any of the grain produced considered as bonus. Typically fodder yields from farmers' field are within the range of 400-500 kg ha $^{-1}$ of dry fodder[3].

The use of insecticides is pivotal in cowpea production. Hitherto, several insecticidal formulations have been manufactured and are on sale in the open market. Variations in the formulation and activity of insecticides have been noted[4]. Illiteracy and a low level of awareness among the farmers could affect negatively the choice of insecticides. Also the crop growing environment (macro and micro) have remarkable effect on crop growth and development to Allard[5]. In the same vein variations in pedoclimatic factors in Adamawa state has been substantiated[6].

Several stability models are presently in use for the understanding of the concept of genotype x environment interaction and evolving stable genotype. There have been strong arguments for and against each stability statistics. However, Kang[7, 8] highlighted the need for integrating yield with stability in selecting high yielding stable genotypes. The concept of stability of performance as measured for morpho-agronomic characters and yield in crops have been extensively studied Dixon and Mba[9]. Studies on the evaluation of stability of performance for fodder yield in cowpea across insecticidal environment are limited. The outcome of this evaluation will assist to identity cowpea genotypes with stable performance across insecticidal environment. Also it will suggest the best insecticidal environment for fodder production.

This present investigation intend to achieve the following objectives

- To evaluate the performance of fodder yield in cowpea genotypes across insecticidal environments
- To identify the most stable cowpea genotypes for fodder production.
- To recommend the best insecticidal environment for fodder production in cowpea.

MATERIALS AND METHODS

Cowpea genotypes used in this evaluation were sourced from the germplasm collection of the International Institute of Tropical Agriculture Ibadan and Adamawa State University, Mubi Nigeria Table 1. Field evaluation was done at the Teaching and Research Farm, Adamawa State University, Mubi (Lon 13°E, Lat 10.1 N, 599 m asl), in 2005 planting season. The field design was a split plot arrangement in a randomized complete block design with three replications. The plot size was 4×3 m, a total of twenty-two plot constitute a replication. The twenty-two cowpea genotype were allocated to the main plot of the experiment. While the insecticidal sprays (Karate EC, Nuvacron EC, Decis EC, Perfekthion EC) were allotted to the subplot of the experiment. Planting was done on the 3rd of August 2005, two seed of each genotype was planted per hole, 2-3 cm deep with intra row spacing of 0.30 cm and inter row spacing of 0.75 cm and plots were separated by 2 m alley. The net plot of the experiment constitutes the two middle rows. Weeding was carried out manually using the hoe at two weeks after planting and repeated at flower budding stage. Fertilizer application 60 kg of P_2O_5 Ha^{-1} was done three weeks after planting and repeated at flowering. The insecticidal sprays (Karate EC, Nuvacron EC, Decis EC Perfekthion EC), were applied at the rate of 4 mls/10 lit of water, at flower budding and at mid podding stages of growth. After the first and second harvesting of pods, the fodder yield per plot was determined by gathering all the leaves, stems of all the plants in the two middle rows and weighed. (kg).

Table 1: List of cowpea genotypes evaluated in the study

Cowpea genotypes evaluated in the study	Place of collection
IT 00K-1217	IITA
IT 00K-901-5	IITA
IT 86D-716	IITA
IT 86D-1010	IITA
IT86D-719	IITA
IT93K-452-1	IITA
IT499-65	IITA
IT97K503-1	IITA
IT-97K556-4	IITA
IT 97K-556-10	IITA
IT97K-818-36	IITA
IT-1069-6	IITA
IT-99D-1399	IITA
IT98K-1111-1	IITA
Danila	IITA
IAR 48	IITA
IT84s 2246-4	IITA
IT89KD-374-57	IITA
IT89KD-288	IITA
IT 90K-277-2	IITA
Tvx 3236	IITA
Mobi 1	Adamawastate

Data collected were summarized and analyzed using the Generalized Linear Model (GLM) procedure of Statistical Analysis System (SAS). Using the sPerkins and Jinks[10], Wricke[11], Shukla[12] stability variance, Plaisted and Peterson, Coefficient of Variation and Regression analysis, the stability of fodder yield across insecticidal environment was determined. Interrelationships among stability models and fodder yield were done using the Pearson correlation analysis. Parameters with correlation coefficient r = 1.00, were grouped together as similar. A representative of each group was selected and in addition to fodder yield was used in getting the rank sum for each genotype in the data set.

RESULTS AND DISCUSSION

Mean fodder yield: The mean fodder yield among the twenty-genotypes of cowpea evaluated is shown in Table 2. Across insecticidal environment, fodder yield maximum (4.25kg) in IT90K277-2 and minimum (1.43 kg) in IT 00K1217. Other cowpea genotypes (IT 90K-277-2, IAR 48, IT 97K-503-1, IT 89KD-374-57, IT97K-556-4, Mnbi local and IT-93 K-452-1) recorded mean values greater the grand mean yield for fodder production (2.87 kg). The mean fodder yield for each insecticidal environment range between 1.38 kg (Perfekthion EC) and 3.73Kg (Karate EC) Table 3.

Variance components analysis: The Generalized Linear Model (GLM) of SAS returned a statistically significant ($p<0.01$, $p<0.001$) mean squares for insecticidal environment for both fodder yield/plant and fodder yield/plot (Table 4). Meaning that the insecticidal environments moderated the performance of fodder yield among the cowpea genotypes. Thus highlighting the relative importance of insecticides as a principal factor in cowpea production. Significant Genotype x Environment interaction revealed inconsistencies of fodder production among the cowpea genotypes evaluated across insecticidal environment. This limit the accuracy of fodder yield estimates and complicate the identification of cowpea genotypes for fodder yield.

Interrelationships amongst stability parameter: The interrelationships among ten stability parameters and fodder yield (Kg) as shown in Table 3 revealed a positive, statistically significant ($p<0.01$) correlation coefficient in the association between the mean fodder yield and fodder yield variance ($r = 0.59^*$). Perkins and Jinks variance

Table 2: Mean fodder yield (kg) per plot for cowpea genotypes evaluated

Cowpea genotypes	Mean yield
IAR 48	4.25
IT97K503-1	3.65
IT89KD-374-57	3.62
IT 97K-556-10	3.45
IT 00K-901-5	3.36
Mubi 1	3.35
IT93K-452-1	3.19
IT -499-65	2.98
IT 86D-716	2.83
IT-277-2	2.82
Tvx 3236	2.48
IT84s 2246-4	2.46
IT98K-1111-1	2.45
IT-1069-6	2.15
Danila	2.07
IT89KD-288	2.01
IT86D-719	1.98
IT-99D-1399	1.90
IT97K-818-36	1.84
IT 86D-1010	1.76
IT 86-568	1.65
IT 00K-1217	1.43
Grand mean	2.62

Table 3: Mean fodder yield across insecticidal environment

Insecticidal environment	Mean fodder yield
E_1	3.75
E_2	2.97
E_3	2.57
E_4	1.38
Grand mean	2.67

E_1= Karate EC, E_2= Nuvacron EC, E_3= Decis, E_4= Perfekthion EC

Table 4: Combined analysis of variance for fodder yield in cowpea genotypes

Source of variation	df	Fodder yield (kg)	Fodder yield/plant
Replications	2	9.63*	8.10*
Environment (insecticides)	3	8.95*	231.04***
Genotypes	31	8.00*	66.73***
Genotype x environment	63	7.55*	78.96***
Error	164	2.72	2.95
CV		63.82	85.71
Mean		2.62	10.94
R^2		0.63*	0.94*

* = Significant at 1% level of probability

(0.68*), Finlay and Wilkinson variance (r = 0.68*), Wricke stability model (r = 0.56*), Plaisted and Peterson (1959) (r = 0.56*) and Shukla (1972) stability variance (r = 0.56*). This indicated that these stability models could appropriately predict and estimate fodder yield potential among cowpea genotypes across insecticidal environment. Conversely the mean fodder yield correlated negatively with regression square (r = -0.41*), Plaisted and Peterson (1960) (r = -0.56**) and adjusted regression square (r = -0.41*). This association indicated that these stability models may not adequately predict the stability of performance as measured for fodder yield across insecticidal environment.

As shown in Table 5, a statistically significant (p<0.01) association between Shukla[12] stability variance and the coefficient of variability for fodder yield (r = 0.68*), variance due to fodder yield (r = 0.97*), Perkins and Jinks variance (r = 0.95*) and Finlay and Wilkinson variance (r = 0.95*), suggest a high degree of similarity among these models in evaluating the concept of stability of fodder yield in cowpea across insecticidal environment. The association analysis further indicated that correlation coefficient r = 1.00 was recorded in the association between Finlay and Wilkinson variance[13](FWvar) and Perkins and Jinks regression slope (PJvar), Plaisted stability parameter and Wricke stability parameter, adjusted R^2 (Adj.Rsq) and regression square, Plaisted and Wricke[11] parameter, Plaisted and Peterson[11] and Wricke[11], Shukla [12] stability variance and Wricke ,[11] Shukla[12] and Wricke[11], Shukla[12] stability variance and Plaisted regression estimate. Obtaining correlation r = 1.00 between any stability parameter indicated that the two parameters are essentially the same. Obviously they will estimates the same aspect of stability with the same degree of precision and accuracy. In a similar study Dixon and Mba[9] recorded correlation coefficient r = 1.00 among stability models in cassava (*Manihot esculenta*). Stability models with correlation coefficient (r = 1.00) were grouped together, since they measure the same aspect of stability. Therefore eight groups were identified as given above. Both the coefficient of variation and fodder yield did not record correlation coefficient r = 1.00 with any stability parameter.

Stability parameters were arbitrarily selected as representative of each of the eight groups identified above. These in addition to fodder yield were assigned ranks and their rank sum computed for each of the genotype in the data set. In evaluating the stability of fodder yield, the regression coefficient of Finlay and Wilkinson[13] ranged between 0.14 (IT 97K-503-1) and 4.28 (Tvx 3236) Table 6. For selection purposes, regression coefficient significantly greater then 1.00 are sensitive to changes in insecticidal environment, hence undesirable. Cowpea genotypes with regression coefficient (b) less than 1.00 and mean fodder yield below the grand mean yield are better adapted to poor insecticidal environment, IT 98K-503-1, IT-86D-1010 and IT 99D-1399 were ranked 1, 2 and 3, respectively. The Perkins and Jinks stability model identified IT 97K-556-10 to have recorded the least rank score among the genotypes evaluated in this study. Wricke[11] stability model returned IT 98K-1111-1 with regression coefficient of 0.23 and the least rank score among other cowpea genotypes evaluated. This was closely followed by IT 86D-719 and IT 86D-1010. The Shukla stability variance picked cowpea genotypes similar to that of Wricke[11] model, but with a slight difference. These genotypes could be of stable performance as measured for fodder yield across insecticidal environment. Using the Plaisted and Peterson stability parameter,

Table 5: Correlation coefficient among stability parameters and fodder yield among twenty-two cowpea genotypes

	Fwb_1	Pjb1	Mfdr	Fycv	Fyvar	Pjvar	Fwvar	Wricke	Rsq	AdjR2	PP59	Pl60	Shukla
Fwb_1	1.00	1.00*	0.13	0.03	0.09	0.03	0.04	0.14	0.25	0.25	-0.14	0.14	-0.14
Pjb1		1.00	0.13	-0.03	0.09	0.04	0.04	-0.14	0.25	0.25	-0.14	0.14	0.14
Mfdr			1.00	-0.07	0.59*	0.68	0.68	0.56*	-0.41**	-0.41**	0.56*	-0.56*	0.56*
Fycv				1.00	0.68*	0.56*	0.56*	0.68*	0.02	0.02	0.68*	-0.68*	0.68*
Fyvar					1.00	0.97*	0.97*	0.97*	-0.23	0.23	0.97*	-0.97*	0.97
Pjvar						1.00	1.00*	0.95*	-0.40	-0.40	0.95*	-0.95*	0.95*
Fwvar							1.00	0.95*	-0.40	-0.40	0.95*	-0.95*	0.95*
Wricke								1.00	-0.23	-0.29	1.00*	1.00*	1.00*
									1.00	1.00*	-0.29	0.29	-0.29
AdjR2										1.00-	-0.29	0.29	-0.28
PP59											1.00	-1.00*	1.00*
Pl60												1.00	-1.00
Shukla													1.00

Fwb_1 = Finlay and Wilkinson variance, Pjb_1 = Perkins and Jinks variance, Mfdr = Mean fodder yield, Fycv = Fodder yield coefficient of variation, Fyvar = Fodder yield variance, PJvar = Perkins and Jinks variance, Fwvar = Finlay and Wilkinson variance, Wricke = Wricke[11], Rsq = Regression square, Adj Rsq = Adjusted regression square, PP1959 = P, Plaisted, Shukld = Shukla[12] stability variance, * = Significant at 5% level of probability, ** = Significant at 1% level of probability

Table 6: Stability parameters rank score and rank sum of fodder yield in twenty-two genotypes of cowpea

Varieties	Finlay and wilkinson (b_1)	Rank	Perkins and jinks(b_1)	Rank	Wrickes	Rank	Rsq	Rank	Shukla	Rank
IT00K-217	-2.41	15	-3.41	21	26.92	17	0.55	18	7.21	14
IT00K-901-5	2.29	13	1.29	11	16.47	14	0.32	13	5.64	12
IT 86D-716	-1.06	7	-2.66	17	7.44	7	0.41	17	2.33	7
IT86D-1010	0.26	2	-0.76	6	4.02	3	0.02	2	1.07	3
IT86D-719	1.69	8	0.69	4	2.41	2	0.07	3	0.48	2
IT93K-452-1	0.84	4	-1.16	9	7.39	6	0.11	6	2.31	6
IT499-65	1.95	11	0.95	8	26.33	16	0.16	10	9.25	15
IT97K503-1	0.14	1	-0.86	7	16.00	13	0.002	1	5.42	11
IT-97K556-4	-2.35	14	-3.35	20	60.12	19	0.14	8	21.64	18
IT 97K-556-100	1.03	6	0.03	1	6.84	5	0.17	9	2.00	5
IT97K-818-36	2.89	16	1.89	13	10.73	10	0.63	19	3.53	9
IT-1069-6	2.94	18	1.94	14	8.29	8	0.76	20	20.64	17
IT-99D-1399	0.77	3	-0.23	3	11.10	11	0.06	4	3.67	10
IT98K-1111-1	0.86	5	0.13	2	0.33	1	0.77	21	-0.28	1
Danila	3.60	20	2.00	15	5.13	4	1.00	22	1.48	4
IAR 48	2.89	17	1.39	12	67.07	20	0.10	5	24.10	19
IT84s2246-4	-1.09	8	-2.19	16	18.28	15	0.13	7	6.32	13
IT89KD-374-57	2.20	12	1.20	10	13.13	12	0.35	14	46.41	22
IT89KD-288	1.74	10	0.74	5	10.14	9	0.29	12	3.32	8
IT 90K-277-2	4.21	21	-5.21	22	74.33	22	0.36	15	26.85	21
Mubi1	3.12	19	2.92	18	71.95	21	0.24	11	25.98	20
Tvx 3236	4.28	22	3.25	19	47.65	18	0.41	16	11.07	16

Varieties	Plaited and peterson	Rank	Plaisted (1959)	Rank	CV	Rank	Fodder yld	Rank	Rank sum
IT00K-217	7.67	16	8.66	22	35.66	6	1.43	22	151
IT00K901-5	6.87	14	8.14	9	46.54	9	3.26	6	101
IT86D-716	5.31	7	8.30	16	21.22	2	2.33	9	89
IT86D-1010	4.72	3	8.36	19	34.80	5	1.76	21	64
IT86D-719	4.43	2	8.39	20	39.28	8	1.98	17	67
IT93K-452-1	5.30	6	8.31	17	30.00	3	3.19	8	65
IT499-65	5.61	17	7.97	6	55.66	14	3.28	7	104
IT97K503-1	6.79	13	8.15	10	31.96	4	4.04	3	63
IT-97K556-4	14.51	19	7.37	4	70.12	18	3.46	5	123
IT97K-556-100	5.16	5	8.13	8	48.65	10	1.92	18	67
IT97K-818-36	5.89	10	8.24	13	74.17	19	1.84	20	129
IT-1069-6	5.46	8	8.28	15	51.13	12	2.48	12	124
IT-99D-1399	5.95	11	8.23	12	60.32	15	1.90	19	87
IT98K-1111-1	4.07	1	8.42	15	15.98	1	2.34	14	48
Danila	4.91	4	8.34	18	54.54	13	2.07	15	102
IAR 48	15.72	20	7.26	3	66.56	17	4.25	1	114
IT84S2246-4	7.21	15	8.11	7	50.72	11	2.46	13	105
IT89KD-374-57	6.30	12	8.20	11	38.49	7	3.62	4	104
IT89KD-288	5.78	9	8.25	14	60.53	16	2.01	16	99
IT90K-277-2	17.00	22	7.13	2	93.34	21	2.82	10	156
Mubil	16.57	21	7.11	1	73.65	20	4.07	2	133
Tvx 3236	12.33	18	7.60	5	98.79	22	2.55	11	147

IT-98K-1111-1 and IT 86D-719, IT 00K-1010, were picked to be of stable performance for fodder yield. The coefficient of variability (CV), Wricke (1960) and Shukla (1972) stability model identified IT 86D-719, IT 98K-1111-1 to be of stable performance. But IT-00K-1217, IT86D-1010 and Dan ila were preferred to be of stable performance by both Wricke[11] and Shukla[12] models.

The study indicated that IT98K-1111-1, IT 86D-719, IT 86D-1010 IT 97K-503-1 and IT93K-452-1, which recorded the least rank sum were identified to be of a high and stable performance for fodder yield, when evaluated across insecticidal environment. Therefore for optimal performance for fodder yield any of these cowpea genotypes could be selected for fodder production as feed for livestock industry. However, any of the insecticides evaluated in the study could provide an above average performance for fodder yield.

ACKNOWLEDGEMENT

This research was funded by the Adamawa State University Board for Research.

REFERENCES

1. Singh, B.B. and Tarawali, 1997. Cowpea and its importance; Key to sustainable mixed crop-livestock farming system in West Africa. Pages 79-100 in Crop residues in sustainable mixed crop-livestock farming systems. Edited by C. Renold. Intl. Crop Res. Institute for Semi Arid farming Tropics (ICRISAT), Intl. Livestock Research Institute (ILRI) and CAB Intl., Wallingford, UK.
2. Steiner, K.G., 1982. Intercropping in tropical small holder agriculture with special refernce to west Africa. Schrirfenneive de GTC No. 137. Deuthe Gesellschaft Fur Technische Zusammenarrbeit (GTZ).
3. Tarawali, S.A., 1991. Preliminary agronomic evaluation of forage legumes for Sub humid West Africa West Africa. Trop. Agric. (Trinidad), 68: 88-94.
4. Jackai, L.E.N., 1995. Legume pod borer (*Maruca vitrata*) and its principal host plant, *Vigna unguiculata* (L.) Walp. Use of selective insecticides as an aid to in identification of useful level of resistance. Crop Protec., 14: 299-306.
5. Allard, A.N., 1960. In Principles of plant breeding, John Willey Inc. New York. Chichester Brisbane. Toronto, Singapore, pp: 467.
6. Adebayo and Tukur, 1999. Adamawa in the Maps 1st Edn, Paraclete Publishers, pp: 111.
7. Kang, M.S., 1988. A rank sum method for selecting high yielding, stable corn genotypes. Cereal Res. Communicat., 16: 113-115.
8. Kang, M.S., 1993. Simultaneous selection for grain yield and stability cosequence for growers. Agron. J., 85: 745-757.
9. Mba, R.E.C. and A.G.O. Dixon, 1995. Correlation studies among yield and various stability parameters and an enlarged rank sum method for identifying high yielding stable cassava clones. Proc. 6th Symp. ISTRC-AB, 1995, pp: 261-266.
10. Perkins, J.M. and J.L. Jinks, 1968. Environmental and Genotype-environmental components of varaiobilty.III: Multiple lines and crosses. Heredity, 23: 339-356.
11. Wricke, G., 1962 Uber eine Methods zur Erfassung der okologischen Streubreite in Feldversuchen. Z. Planzenzucht, 47: 92-96.
12. Shukla, G.K., 1972. Some statistical aspects of partitioning genotype x environmental components of variability. Heredity, 29: 237-245.
13. Finlay, K.W. and G.H. Wilkinson, 1963. The analysis of adaptation in a plant breeding programme. Australian J. Agric. Res., 14: 742-754.