Agricultural Journal 2 (5): 617- 621, 2007

Reaction of Agronomic and Reproductive Characters of Cowpea Breeding Lines under *Meloidgyne inchognita* Inoculation

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Abstract: The reaction of agronomic and reproductive characters of fourteen cowpea breeding lines was evaluated under *Meloidogyne inchognita* inoculation. Significant differences (p>0.05) was recorded for most characters evaluated. The high degree of variation in seed weight was confirmed by the Coefficient of Variability (CV%) for seed yield. Conversely, the number of days to first flowering recorded a low variability (CV%), this attest a similar response among the breeding lines. The number of pods plant^{-1} and loculi was high in IT 568, pod length was maximum in IT 625. The study indicated that under *Meloidogyne inchognita* inoculation, earliness among the breeding lines was directly influenced by some characters. In addition the number of loculi pod^{-1} was influenced by the number of trifoliate, seeds pod^{-1}, fodder weight plant^{-1} and pod weight, pod wall weight and root weight. The stepwise contribution of characters to seed weight returned the fodder weight plant^{-1} as most important character. The number of pods plant^{-1} (Y) was influenced largely by the contribution of fodder weight plant^{-1} and pods plant^{-1}. The study indicated that both agronomic and reproductive are largely influence by inoculation of *Meloidogyne inchognita*. IT 568 and IT 2246-4 were identified for seed yield potential under *Meloidogyne inchognita* inoculation.

Key words: Earliness, seed yield, fodder yield, variation, *Meloidogyne inchognita* cowpea

INTRODUCTION

Cowpea (*Vigna unguiculata*) is cultivated largely for fodder and grain in North Eastern Nigeria (Adeniji, 2006) Legumes serve as alternative supplements to animal protein, particularly in parts of the world, where there is paucity of animal protein due to socioeconomic constraints (Ojimelelukwe, 2002). Cowpea (*Vigna unguiculata* [L] Walp) is nutritious legume crop that is of considerable importance in Nigeria and other sub Sahalian countries. They constitute a significant proportion of the total dietary protein and energy intake of Nigerians (Ojimelelukwe, 2002). The cultivation of cowpea for fodder and grain is a predominant occupation in the Northern Guinea and Sudan savannah of Nigeria. Desirability for dual purpose cowpea is due to non availability of livestock feeds during the prolong dry season for grazing animals.

Meliodogyne inchognita also known as root knot nematode is premier pests of tropical agriculture and cowpea genotypes are particularly susceptible. Root knot nematode (rkn), *Meloidogyne inchognita* is an important plant parasitic nematodes pests and a major cause of crop losses and thus limiting agricultural productivity. The crop damage by nematode is high and comparable to that of other pests. The above ground symptoms are dwarfing, patching growth of the plant and poor and few pod formation. In areas where root knot nematode are adequately managed, averaged crop yield losses are likely to be in neighborhood of 25% with damages from individual fields as high as 60-80% (Afolami *et al*., 2004). Afolami *et al*. (2004) had stressed that since nematode spread slowly and persistent in soil for long time coupled with the fact that nematode management by physical and chemical means are relatively expensive. Therefore, the use of attractive, effective and economical management strategy for minimizing losses and optimize yield are quite adequate. Plant-parasitic nematodes are important cowpea production constraints with several species of them playing a major role in reduction of cowpea production in Northern Eastern Nigeria. The availability of resistant varieties is often the only economic resource for nematode management available to the growers of low value crop (Rodguiguez-Kabana, 1992).

Cowpea cultivation contributes significantly to the economy of resource poor farmers in Adamawa state. The desirability for fodder and grain yield in cowpea among farmers in Adamawa state is high. This could be limited by a number of production as well as pathological constrains. *Meloidogyne inchognita* has been identified as a predominant pest in cowpea cultivation in most farming communities in the state. They account for over 80% yield

loss in cowpea production. During attack by nematode the physiological state of the plant is disturbed. Symptom associated with nematode attack includes loss of photosynthetic parts, distortion in growth and low yield. The availability of tolerant and resistant varieties is limited in the cropping system. Existing genotypes are susceptible to *Meloidogyne inchognita* attack. Information on the reaction of agronomic characters under *Meloidogyne inchognita* is limited as compared with evaluation of nematode symptoms. Therefore, an evaluation of the reaction of agronomic and reproductive characters in cowpea breeding lines to *Meloidogyne inchognita* could provide research information ideal for improvement and advancing research for improvement in this environment.
The objectives of this study are:

- To evaluate the variation among agronomic and reproductive characters of cowpea breeding lines under *Meloidogyne incognita* inoculation.
- To evaluate association, relationships and contribution of characters to pod and seed yield under *Meloidogyne incognita* infestation.
- To discriminate among the cowpea breeding under *Meloidogyne inchognita* attack.

MATERIALS AND METHODS

Evaluation of variation in reaction of agronomic and reproductive characters of cowpea under inoculation with *Meloidogyne inchognita* inoculation was carried out at the screen house, Department of Crop Science, Adamawa State University. The top soil was collected from the fadama land near the University, mixed thoroughly and heat sterilized using electric soil sterilizer at 85°C for 1 h and 30 min. The sterilized soil was allowed to cool, packed into jute sacks and left for 6 weeks to restore its stability. Four kilograms of sterilized soil was weighed into each of the buckets used as pots. The pots were arranged in the screen house in a Completely Randomized Design with three replications. Three pots were allocated to each breeding line in a replicate. A total of one hundred and twenty-six pots were used for this evaluation. Fourteen cowpea breeding lines presently under field evaluation at several locations in Nigeria were sourced from the germplasm collection of the International Institute of Tropical Agriculture, Ibadan. Two seeds of each genotype were planted per hole 2-3 cm deep, inoculation of 250 egg masses of *Meloidogyne inchognita* per pot was done at 10 days after planting. Agronomic activities carried out include thinning, weeding, fertilizer application and insecticidal application. Nuvacron EC and Karate EC were sprayed at the rate of 40 mLs 10 L^{-1} of water at flower budding stage and at flowering. The plant heights at flower budding stage and at flowering (cm) were measured with a meter rule from the ground level to the top of the main stem in centimeter. While the length and width of the leaves was measured on the longest and widest points (cm) on the leaves at flowering. The pod length was measured on the longest point on the pods in centimeters. By counting the numbers of days from planting, the days to flower bud appurtenance and flowering were estimated. Other characters evaluated includes the number of leaves (trifoliate) per plant at flower budding stage, pods $plant^{-1}$, pod weight, pod wall weight, seed weight and root weight. All weight measurements were carried out a sensitive weigh balance.

Data collected on all agronomic and reproductive characters were summarized and subjected to statistical analysis. Variation for reproductive and agronomic characters among the breeding lines evaluated using the Generalized Linear Model of the Statistical Institute (SAS, 2004). Using PROC CORR procedure of statistical Analysis, association among various characters was determined. Using seed weight, pods $plant^{-1}$ seed/pods and loculi pod^{-1} as dependent variable (Y), the multiple regression analysis was carried out. The principal Components Analysis was used to discriminate among the breeding lines evaluated in the study.

RESULTS AND DISCUSSION

Mean squares for morphological and reproductive characters of the fourteen breeding lines under *Meloidogyne inchognita* inoculation are presented in Table 1. Significant differences were ($p<0.05$) recorded for among the breeding lines for height at flower budding, days to flower bud appearance, days to flowering, height at flowering, leaf length at flowering, pod length, seeds pod^{-1}, loculi pod^{-1}, fodder yield $plant^{-}$, ^{1}pod weight $plant^{-1}$, pod wall weight, seed weight and root weight. This suggest the magnitude of variation among the breeding lines for these characters under *Meloidogyne inchognita* infestation. The foregoing is a clear indication of the magnitude of variation as recorded for these character might have resulted from a differential response among the breeding lines evaluated. This could provide basis selection and genetic improvement. Estimates of the Coefficient of Variability (CV) were high for seed weight and least for days to first flowering. Implying that high degree of variation in seed yield could be exploited for developing lines tolerant to *Meloidogyne inchognita*. The low variability for earliness among the breeding lines denotes a similar response for earliness. As shown in Table 2, the mean number of days to flower bud appearance was 37 days in IT 288 and 47 days in IT 131.

Table 1: Mean squares values for agronomic and reproductive characters of cowpea under *Meloidogyne inchognita* inoculation

	Df	htflbd	dflbd	Nolvs	Dff	Htfl	Lvsfl	Lwt	Lvl	Pd/plt	Podl	Spp	Loc/pd	Fdw/plt	Pdwt	Pwwt	swt	Rwt
Rep	2	1.59**	11.01**	1.69	5.38	11.17	4.19**	0.05	0.43	0.09	0.52	0.38	0.64	0.50**	0.20	0.30	0.01	0.006
Var	13	69.44**	6.45**	1.25	95.46	35.18**	1.52	0.46	3.71**	1.05	17.83	6.48	6.48**	4.88**	0.76**	3.90	3.53**	0.06
Error	26	9.99	2.40	0.77	12.23	8.36	1.57	8.27	0.29	0.61	0.61	1.64	1.92	0.13	0.30	0.12	1.28	0.001
R2		0.75	0.71	0.48	0.80	0.69	0.58	0.46	0.87	0.47	0.47	0.67	0.63	0.98	0.67	0.94	0.58	0.94
CV		15.5	8.73	24.31	6.69	14.18	29.61	23.62	8.75	28.83	28.23	26.87	18.86	15.30	42.86	55.43	119.54	17.21
Mean		20.28	41.55	4.33	53.09	20.40	4.23	0.52	6.04	0.78	0.78	4.76	7.36	2.40	1.04	0.62	0.95	0.26

Htflbd= Height at flowering, dflbd= Days to flower budding, Nolvs= Number of leaves, Dff= Days to first flowering, Htfl=Height at flowering, Htfl Numbert of leaves at flowering, Lwt= Leaves width, Lvl=Leaves width, Pd/plt= Pods plant^{-1},= Pod length, Spp= Seeds pod^{-1}, Loc/pd= Loculi /pod, Fdw/plt= Fodder weight plant^{-1}, Pdwt=Pod weight, Pdwwt= Pod wall weight, Swt= Seed weight, Rwt= Root weight

Table 2: Mean values of agronomic and reproductive characters of cowpea breeding lines under *Meloidogyne inchognita*.inoculation

Varieties	Lvwfl	Lvlfl	Pd/pl	Pdl	Spp	Loc/pd	Fdwt/pl	Htflbd	Dflbd	Nolvs	Htfl	Nolvfl	Swt	Rwt
IT 2246	1.93 a	5.67de	3.67a	11.03ab	6.00ab	8.67abc	2.36c	29.00a	39.00bc	4.33ab	21.00bc	4.33bc	0.49c	0.64a
IT 499	2.07b	5.30e	2.33abc	9.07abc	6.33ab	7.67abcd	2.57bc	24.9ab	39.00bc	3.67b	23.00abc	3.67bc	4.05a	0.24ac
IT 111	2.2ab	5.63de	2.67abc	8.37bcd	5.33abc	8.00abcd	2.15c	24.67ab	43.67a	4.00ab	17.7	3.67bc	0.37c	0.22de
IT 716	3.67a	6.97ab	2.33abc	9.47abc	2.0d	4.67e	0.62d	24.67ab	42.33a	3.67b	18.67bcd	5.00abc	0.37c	0.17efg
IT 288	1.83b	6.57bcd	2.33abc	4.47ef	4.33bcd	6.67bcde	2.42c	22.67bc	37.00c	4.33ab	20.00bc	3.00c	0.48c	0.33c
IT 818	2.33ab	6.13cde	3.00abc	9.53abc	7.67a	9.33ab	2.66bc	21.67bcd	42.00a	4.33ab	18.10cd	6.00ab	0.94bc	0.41b
IT 227	2.73ab	7.40ab	3.33ab	6.33edf	4.00bcd	5.67de	2.73bc	20.33bcde	41.67ab	5.33ab	24.17ab	3.67bc	0.83bc	0.17efg
IT 1263	1.87b	7.60a	2.67abc	9.67abc	3.67bcd	6.67bcde	1.09d	20.00cdef	43.00a	4.00ab	27.30	3.67bc	0.47c	0.12fg
IT 503	1.90b	3.97f	3.00abc	6.17def	4.00bcd	6.33cde	0.42d	18.33cdef	42.67a	3.67b	17.67cd	3.33c	0.36c	0.19ef
IT 131	2.67ab	5.57de	3.00abc	3.80f	4.00bcd	6.00cde	0.87d	18.00cdef	46.67a	3.67b	20.33bc	4.00bc	0.22c	0.10g
IT 568	2.40ab	6.07cde	3.67a	11.27a	3.67cd	10.00a	2.08c	16.30def	42.00a	5.00ab	14.23d	4.67bc	0.85bc	0.17efg
IT 901	1.93b	5.97de	2.60bc	7.00cde	5.32abc	7.67abcd	3.10b	14.67ef	41.67ab	4.67ab	20.67bc	7.00a	0.73bc	0.29cd
IT 625	1.87b	7.47ab	3.00abc	11.17a	4.00bcd	7.33abcd	1.07d	14.67ef	42.33a	5.67a	24.07ab	2.67c	0.39c	0.22de
IT 128	1.97b	4.23f	1.67e	9.87ab	6.33ab	7.00abcd	1.28a	14.0f	41.67ab	4.33ab	17.07cd	4.67bc	2.71ab	0.33c

Htflbd= Height at flowering, dflbd= Days to flower budding, Nolvs= Number of leaves, Dff= Days to first flowering, Htfl=Height at flowering, Htfl Numbert of leaves at flowering, Lwt= Leaves width, Lvl=Leaves width, Pd/plt= Pods plant^{-1},= Pod length, Spp= Seeds pod^{-1}, Loc/pd= Loculi /pod, Fdw/plt= Fodder weight plant^{-1}, Pdwt=Pod weight, Pdwwt= Pod wall weight, Swt= Seed weight, Rwt= Root weight

This is the required number of days for attainment of late podding in the breeding lines having been breed for earliness. This is an indication that the inoculation of *Meloidogyne inchognita* might have altered the number of day required for earliness and consequently maturity. This is possible through a disruption in the physiology of the plant. The magnitude of variation as found in this study could provide basis for selection purposes. However, these varieties could be selected for earliness under *Meloidogyne inchognita* inoculation. The number of pods plant^{-1} was high in IT 84s 2246-4 and IT 568. Also IT 499 recorded a high seed yield, while IT 126 recorded a relatively high value for seed yield. The number of pods plant^{-1} was high in IT 84s-2246-4, IT 818, IT227, IT 131, IT 568 and IT 625. The number of loculi pod^{-1} presented a variation between 6 loculi in IT 503 and 10 in IT 568. While pod length was maximum in IT 625 and lowest in IT 131. Under nematode inoculation, the number of seeds pod^{-1} was high in IT 818 and low in IT 716. The seed yield plant^{-1} (g) presented a variation between 0.22 in IT 131 and 4.05 in IT 499. Also IT 128 recorded a high seed yield. IT84s-2246-4, IT499,IT 625, IT 818, IT 503 could be selected for genetic studies desirable for yield and yield components.

The correlation analysis among the characters evaluated as shown in Table 3 indicated that the number of days to flowering correlated positively with seed pod^{-1}, fodder weight plant^{-1}, pod weight, pod wall weight and seed weight. The foregoing provides that under *Meloidogyne inchognita* inoculation, earliness among the breeding lines was directly influenced by these characters. Selection of these characters could influence earliness among the breeding lines. However, these correlation coefficients were positive and statistically significant. In addition the number of loculi pod^{-1} was influenced positively by the number of trifoliate, seeds pod^{-1}, fodder weight plant^{-1} and pod weight, pod wall weight and root weight. This is a clear indication of a positive association between the reproductive and physiological characters. This could as well be traced to a complementation in the manufacture, distribution and assimilation of photosynthate in the seeds. A negative and statistically significant ($p<0.05$) correlation coefficient between the number of pods plant^{-1} and seed weight, fodder weight plant^{-1} suggest an independent association among the characters. This suggests a competition in the distribution and accumulation of dry weights should be expected. A competition in the distribution and accumulation of dry weight in the seed and fodder was confirmed by a negative correlation coefficients recorded among the characters evaluated (Table 4). However, a complementation in the association between root weight and pod length, seed/pod, loculi pod^{-1}, fodder weight plant^{-1}, pod weight, pod wall weight was recorded. Findings obtained from this observation do not differ from previous reports by (Ojimelukwe, 2002) for cowpea evaluated under no inoculation of ***Meloidogyne inchognita*.**

Table 3: Stepwise contributionof agronomic and reproductive characters to seed yield in cowpea under Meloidogyne inchognita inoculation

Variable	Seed weight No in	Partial R2	Model R2
Fodder weight plant^{-1}	1	0.21	0.21**
		Pods plant^{-1}	
Fodder weight plant^{-1}	1	0.13	0.13**
Pods plant^{-1}	2	0.10	0.24**
		Seed pod^{-1}	
Root weight	1	0.25	0.25**
	2	0.12	0.37**
		Loculi pod^{-1}	
Pod weight	1	0.35	0.35**
Leaf width at flowering	2	0.12	0.46**
Pod length	3	0.07	0.54**

Table 4: Correlation coefficients among reproductive characters under Meloidogyne inchognita inoculation

	htflbd	Dflbd	Nolvs	Dff	Ht_fl	Lvsfl	Lvswfl	Lvslfl
htflbd	1.0000	-.2880	-.2233	-.1227	0.1132	-.0849	0.1828	0.0780
Dflbd	-.2880	1.0000	-.1151	0.2473	-.2163	0.0036	0.2335	-.0322
Nolvs	-.2233	-.1151	1.0000	0.0188	0.1165	0.1721	-.0560	0.2582
Dff	-.1227	0.2473	0.0188	1.0000	0.0142	0.1355	0.1217	0.0381
Ht_fl	0.1132	-.2163	0.1165	0.0142	1.0000	-.1192	-.0900	0.4138
Lvsfl	-.0849	0.0036	0.1721	0.1355	-.1192	1.0000	0.0035	-.0711
Lvswfl	0.1828	0.2335	-.0560	0.1217	-.0900	0.0035	1.0000	0.1469
Lvslfl	0.0780	-.0322	0.2582	0.0381	0.4138	-.0711	0.1469	1.0000
Pd_plt	0.1126	0.0059	0.1270	-.2692	0.0237	-.0487	0.1362	0.0802
Pdl	0.0920	0.0086	0.0621	0.1767	-.0586	-.0013	-.0095	0.0875
Spp	0.1093	-.2966	-.0235	0.2747	-.0094	0.1647	-.2311	-.3455
Lo_pd	-.1427	-.1291	0.3149	0.1573	-.3544	0.1688	-.3131	-.2683
Fdwt_plt	-.2834	-.1303	0.1079	0.2996	-.1829	0.1775	-.1492	-.3752
Pdwt	-.0137	0.0516	0.2060	0.3963	-.3460	0.2873	0.0382	-.0621
Pwallwt	-.2819	0.0107	0.0377	0.3283	-.2374	0.1987	-.0649	-.3765
Swt	-.0145	-.2669	0.0242	0.3001	0.0366	-.1125	-.0585	-.2436
Rwt	0.3026	-.4124	0.0762	-.1411	-.1815	0.1801	-.2769	-.2244

Pdl	Spp	Lo_pd	Fdwt_plt	Pdwt	Pwallwt	Swt	Rwt	
0.1126	0.0920	0.1093	-.1427	-.2834	-.0137	-.2819	-.0145	0.3026
0.0059	0.0086	-.2966	-.1291	-.1303	0.0516	0.0107	-.2669	-.4124
0.1270	0.0621	-.0235	0.3149	0.1079	0.2060	0.0377	0.0242	0.0762
-.2692	0.1767	0.2747	0.1573	0.2996	0.3963	0.3283	0.3001	-.1411
0.0237	-.0586	-.0094	-.3544	-.1829	-.3460	-.2374	0.0366	-.1815
-.0487	-.0013	0.1647	0.1688	0.1775	0.2873	0.1987	-.1125	0.1801
0.1362	-.0095	-.2311	-.3131	-.1492	0.0382	-.0649	-.0585	-.2769
0.0802	0.0875	-.3455	-.2683	-.3752	-.0621	-.3765	-.2436	-.2244
1.0000	0.2645	-.1851	0.1352	-.3654	-.0278	-.2757	-.4715	0.0671
0.2645	1.0000	0.1697	0.3723	0.1461	0.1647	0.1967	0.0484	0.2716
-.1851	0.1697	1.0000	0.5896	0.4220	0.4892	0.4466	0.2631	0.5012
0.1352	0.3723	0.5896	1.0000	0.3088	0.5930	0.3150	0.1218	0.4293
-.3654	0.1461	0.4220	0.3088	1.0000	0.2847	0.8704	0.4536	0.3449
-.0278	0.1647	0.4892	0.5930	0.2847	1.0000	0.2907	0.1087	0.4243
-.2757	0.1967	0.4466	0.3150	0.8704	0.2907	1.0000	0.2842	0.2859
-.4715	0.0484	0.2631	0.1218	0.4536	0.1087	0.2842	1.0000	0.0752
0.0671	0.2716	0.5012	0.4293	0.3449	0.4243	0.2859	0.0752	1.0000

Htflbd = Heightat flowering, dflbd = Days to flower budding, Nolvs = Number of leaves, Dff = Days to first flowering, Htfl = Height at flowering, Htfl Numbert of leaves at flowering, Lwt = Leaves width, Lvl = Leaves width, Pd/plt = Pods plant^{-1}, = Pod length, Sp. = Seeds pod^{-1}, Loc/pd = Loculi /pod, Fdw/plt = Fodder weight plant^{-1}, Pdwt=Podweight, Pdwwt= Pod wall weight, Swt= Seed weight, Rwt= Root weight

The stepwise multiple regression analysis using seed weight as dependent variable returned the fodder weight plant^{-1} as most important character to have summarized 21% of observed variation under *Meloidogyne inchognita* inoculation. Other characters were of less important. The number of pods plant^{-1} (Y) was influenced largely by the contribution of fodder weight plant^{-1} (0.15**) and pods plant^{-1} (0.24**). They altogether summarized 24% of variation in pod yield under *Meloidogyne inchognita* inoculation. The root weight and number of days to flowering were of importance in the determination of seeds pod^{-1}. The root weight alone accounted for 25% of variation, while the number of days to flowering contributed 17% of variation. Altogether, they summarized 37% of observed variation in number of seed /pod. Using the number of loculi pod^{-1} as dependent variable (Y), the pod weight independently summarized 35% of variation; the addition of leaf width at flowering,

Table 5: Multivariate analysis of variation among reproductive and agronomic character

Axis	Eigen value	Difference	Proportion	Cumulative
1	4.11	1.97	0.24	0.24
2	2.14	0.27	0.12	0.36
3	1.86	0.30	0.11	0.47
4	1.56	0.16	0.09	0.56
5	1.39	0.28	0.08	0.65
6	1.11	0.16	0.06	0.71

	Eigen vectors					
	Prin1	Prin2	Prin3	Prin4	Prin5	Prin6
htfbd	-0.07	0.33	-0.23	-0.09	0.54	-0.15
Dflbd	-0.09	-0.32	0.4	-0.14	0.06	0.10
Nolvs	0.07	0.14	0.19	0.48	-0.35	-0.08
Dff	0.18	-0.29	0.17	0.32	0.36	0.03
Htfl	-0.17	0.04	-0.30	0.49	0.003	0.05
Lvsfl	0.15	0.03	0.22	0.06	-0.08	-0.62
Lvswfl	-0.13	-0.13	0.24	-0.01	0.49	-0.12
Lvslfl	-0.23	0.10	0.10	0.54	0.09	-0.04
Pd/plt	-0.13	0.41	0.30	-0.08	-0.04	0.25
Pdl	0.14	0.22	0.19	0.13	0.22	0.58
Spp	0.36	0.14	-0.14	0.02	0.15	-0.07
Lo/pd	0.35	0.25	0.20	0.01	-0.13	0.13
Fdwt/plt	0.38	-0.22	-0.10	0.03	-0.09	0.09
Pdwt	0.31	0.11	0.30	0.09	0.20	-0.24
Pwallwt	0.37	-0.22	0.01	-0.03	-0.04	0.11
Swt	0.21	-0.22	-0.35	0.17	0.15	0.14
Rwt	0.28	0.40	-0.13	-0.11	0.03	-0.10

46% of variation was explained. The pod length independently summarized 7% of this variation. Altogether these three characters summarized 54% of variation in loculi pod^{-1}.

The multivariate analysis of variation using the principal component analysis identified six principal to have recorded eigen values above 1.00. The principal axes one to six explained 72% of variation. The highest eigen value was recorded in axis 1 followed by axis 2. Principal axis one summarized 24% of variation, while axis 2,3.4,5 and 6 summarized 13, 11, 9, 8 and 6% of variation. As shown in Table 5, principal axis 1 was largely loaded by fodder weight plant^{-1}, pod wall weight, seeds pod^{-1}, loculi pod^{-1} and pod weight. However, these characters are described as reproductive characters. Conversely principal axis 2 and 4 were described largely by physiological characters.

CONCLUSION

The study indicated a high magnitude of variability among the breeding lines evaluated for reproductive and agronomic characters under *Meloidogyne inchognita* infestation. This is an indication that variation observed among the breeding lines could provide basis for selection and genetic improvement. The number of days to flowering was influenced negatively by disruption in the physiology of the breeding lines under *Meloidogyne inchognita*. Consequently this manifest in longer days to flowering (57 days) as well as maturity. The reaction of the cowpeas breeding lines measured for pod yield under *Meloidogyne inchognita* inoculation identified fodder weight and pods plant^{-1} as determinants of pod yield. In addition, root weight and days to flowering were of importance whenever selection is desirable for seed yield.

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