SOURCES OF RESISTANCE TO THE COMMON COWPEA POD SUCKING BUGS *Riptortus dentipes* (Fabricius) AND *Anoplocnemis curvipes* (Fabricius) IN COWPEA *Vigna unguiculata* (L.) WALP[1] /

*B. M. KHAEMBA**

Resumen

Una muestra mundial de germoplasma de caupí fue evaluada exitosamente en el campo y reveló que la mayoría de ella era susceptible (99.18%) a Riptortus dentipes *(Fabricius) y a* Anoplocnemis curvipes *(Fabricius), a juzgar mediante por una escala de evaluación de 1 a 5, basada en el grupo de encogimiento de las vainas. Treinta y tres (0.82%) cultivares que presentaron de 20 a 39% de daño en sus vainicas (PD) fueron considerados como moderadamente resistentes y fueron seleccionados para efectuar posteriormente pruebas confirmatorias de campo.*

Ocho cultivares, que mostraron en experimentos repetidos de campo niveles razonables de resistencia a los chinches, fueron Emma B (22.5% PD), PS-1 (36.7% PD), PS-2 (33.2% PD), Katumani-1 (22.2% PD), TVu No. 6641 (25.6% PD), 4052 (21.8% PD) y 4339 (22.2% PD).

Pruebas de campo mostraron que algunas características culturales de caupí, específicamente color y morfología externa de las vainicas, grosor de la cubierta, longitud del pedúnculo y posición de la vainica en relación al follaje, contribuyeron a la resistencia de caupí al ataque por R. dentipes *y* A. curvipes

Introduction

Of the several species of hemipteran bugs that attack cowpea pods, *Riptortus dentipes* and *Anoplocnemis curvipes* are the most important (13, 16). The bugs occur throughout Africa wherever cowpeas are grown (2, 5, 6, 9, 14). They cause yield losses estimated between 30 and 70% in Africa (12). In Nigeria, their attack on cowpea can lead to total crop failure in the absence of chemical protection (16).

Despite the destructiveness of *R. dentipes* and *A. curvipes* to cowpea crops in Africa, there is virtually no information on cowpea resistance to them. Recent investigations showed that the bugs cause damage to developing cowpea pods which is similar in nature and because of this, identical methods can be adopted in the search for sources of cowpea resistance to them (4). Reported here are results of field trials of cowpeas *Vigna unguiculata* (L.) Walp in a search for resistant germplasm to *R. dentipes* and *A. curvipes*.

Materials and methods

A genetically diversified sample of world cowpea germplasm consisting of 4180 cultivars was evaluated in the field for resistance to *R. dentipes* and *A. curvipes*. Plantings of the germplasm were made in 1977 (1st and 2nd seasons) and 1978 (1st season in single-row plots unreplicated) spaced 1 m apart. Resistance was judged preharvest four times at weekly intervals starting one week after podding on 1 – 5 visual rating scale based on the degree of pod shrivel (i.e. 1 = 0-19%; 2 = 20-39%; 3 = 40-59%; 4 = 60-79%; 5 = 80-100%). At harvest, 40 pod samples per plot

1 Received for publication on February 10, 1984.
The author acknowledges to Professor T. R. Odhiambo, Director of the International Centre of Insect Physiology and Ecology (ICIPE), for his kind help which enabled the studies reported here to be undertaken. Special thanks are due to Dr. S. R. Singh of the International Institute of Tropical Agriculture (IITA) for his many valuable suggestions with regard to field experimentation of data. He wishes to thank IITA, the International Foundation for Sciences (IFS), University of Nairobi and Ministry of Agriculture, Kenya Government for financial and technical support.

* University of Nairobi, P. O. Box 30197.

were taken and examined to determine the percentage of pods damaged by the bugs. Pod colour (purple, light-green and dark-green) and pod position relative to the canopy were recorded preharvest to assist in identifying resistant cultivars to *R. dentipes* and *A. curvipes*.

From 1977 and 1978 data, 33 cultivars which showed moderate resistance to the bugs were retested in small plots (2.25 x 3.0 m) replicated four times and arranged in complete randomized blocks. Samples of 40 pods per plot were taken at crop maturity and examined to determine percentage pod damage. The cultivars were then grouped according to pod colour and percentage pod damage data analysed to ascertain the involvement of this character in the resistance of cowpea to *R. dentipes* and *A. curvipes*.

In 1979, nine cultivars of agronomic interest were selected out of the 33 cultivars and tested to elucidate the mechanisms of resistance they may possess. At harvest, an assortment of 40 pods per plot were taken. They were then shelled to count damaged seeds and feeding punctures which appeared as black lesions under a binocular microscope on the insides of the pod walls. The length of penduncles was determined by measuring all the penduncles on samples of 5 plants per plot taken at harvest.

From the preliminary casual observations of earlier field experiments it became necessary to conduct a series of experiments in 1980 and 1981 to ascertain the role of the position of pods relative to the canopy and the external morphological characteristics of the pods in cowpea resistance to the bugs. A set of field trials consisted of four cultivars, two of which possessed striking contrasts from the other two in the manner in which their pods were positioned relative to the canopy. Plots (2.25 x 3.0 m) were replicated four times. At harvest a 40-pod sample was taken from each plot and shelled to count seeds damaged by the bugs. Feeding punctures observed on the insides of the pod wall were counted and recorded. Additionally, the length of penducles of each cultivar were measured as described previously.

Finally three cultivars with outstanding contrasts in morphological characteristics were planted in experimental plots (2.25 x 3.0 m) replicated six times. At crop maturity a sample of 40 pods was harvested from each plot. After shelling, damaged seeds and bug feeding punctures were counted. The split plot walls were then measured to calculate their mean thickness.

In all years, indigenous field populations of *R. dentipes* and *A. curvipes* were the primary source of infestation. However, pigeon pea border rows were planted around experimental plots one month prior to seeding test cultivars to attract and harbour the bugs. The rows were usually cut to liberate any bugs to infest the test cultivars at podding stage.

Results

Of the 4180 germplasm cowpea cultivars planted in 1977 and 1978, only 4022 cultivars were successfully evaluated for restistance to *R. dentipes* and *A. curvipes*. The remainder (158) of the cultivars were not evaluated either because they failed to germinate or suffered from severe disease infections leading to poor fruit formation. The bulk (99.21%) of the 4022 cultivars successfully tested were rated susceptible on a 1 – 5 scale and sustained high pod damage in the range of 40-100%. None of the cultivars tested was found to possess a high level of resistance (0-19% pod damage) in the preliminary germplasm screening tests. Thirty-three cultivars (Table 1) which sustained pod damage in the range of 20-39% due to the feeding activities of *R. dentipes* and *A. curvipes* were considered moderately resistant to these pests and were retested in subsequent field trials to elucidate the resistant qualities they may possess.

From 1978 and 1979 data, it was significantly ($P = 0.05$) evident that cultivars with purple (42.2% pod damage) and dark-green (43.0% pod damage) pods were less damaged by *R. dentipes* and *A. curvipes* than cultivars with light-green (59.1% pod damage) pods (Table 1) and were therefore considered as being more resistant to the bugs. However, not all cultivars bearing purple and dark-green pods were resistant to the bugs. For example, Tvu no. 4566 (purple pods) and Tvu no. 2207 (dark-green pods) sustained 69.1% and 60.0% pod damage (Table 1), respectively and were therefore considered as being susceptible. Conversely, not all cultivars bearing light-green pods were found to be susceptible to *R. dentipes* and *A. curvipes*. The evidence of this is that Vita 4 which normally produces light-green pods sustained 19.8% pod damage and because of this it was rated as being resistant. Other cultivars which exhibited reasonably high levels of resistance were: PS – 1 (light-green pods), Emma B and Tvu no. 6641 (purple pods), Tvu nos. 4052 and 4539, Katumani-1 and PS – 2 (dark-green pods).

Table 2 presents data of feeding punctures and seeds damaged per pod of 9 presumably resistant cultivars of agronomic interest. The results showed that feeding punctures, which were taken to indicate feeding preference, varied significantly ($P = 0.5$) among the test cultivars. There were very few feeding punctures on the pod walls of Tvu no. 4049

Table 1. Data of pod damage of 33 cowpea cultivars selected from preliminary field trials for moderate levels of resistance to *Riptortus dentipes* and *Anoplocnemis curvipes* 1977-1978.

Cultivar	Average pod damage (%)
With purple pods	
Tvu no 1890	43 7 cd
Emma B*	22 5 a
Tvu no 4566	69 1 hi
Tvu no 1	40 6 bcd
Tvu no 6641	35 8 bc
Tvu no 3912	42 7 bcd
Tvu no 4588	43 4 cd
Tvu no 4548	40 1 bc
With light-green pods	
PS-1*	36 7 bc
Tvu no 4596	71 6 ij
Vita -4*	19 8 a
Tvu no 6926	80 8 j
Tvu no 3839	56 5 fg
Tvu no 4597	70 6 i
Tvu no 2698	54 3 efg
Tvu no 6572	64 5 fg
Tvu no 470	59 2 gh
Tvu no 6627	57 1 fg
Tvu no 72	78.9 i
Tvu no 6559	75 3 i
PS-5	50 4 defg
With dark-green pods	
Tvu no 4052*	21 8 a
Tvu no 4049	47 1 cdef
Tvu no 4539*	22 2 a
PS -2*	33 2 b
Tvu no 4609	59 1 gh
Tvu no 4620	56 5 fg
Tvu no 4565	45 2 cde
Tvu no 4621	46 0 cde
Tvu no 2207	60 0 g
Tvu no 4600	55 0 efg
Tvu no 4601	48 2 cdef
Katumani -1*	22.2 a

Means followed by the same letter are not significantly different from each other at P = 0 05

* denotes cultivars or accessions with moderate levels of resistance to the bugs

Table 2. Feeding punctures and damaged seeds per pod of nine cowpea cultivars of agronomic interest presumably resistant to *Riptortus dentipes* and *Anoplocnemis curvipes* 1979.

Cultivar	Feeding punctures per pod	Damaged seeds per pod
Vita-4	1 35 a	1 34 a
Emma B	1 71 a	1 59 a
Katumani-1	2 04 a	2 63 c
Tvu no 4052	2 23 b	1 74 ab
Tvu no. 4049	1 21 a	2 21 b
PS-2	2 48 b	2 09 b
Tvu no 4621	1 40 a	2 70 c
Tvu no. 6641	3 24 c	1 63 ab
Tvu no 4601	1 67 a	2 64 c

Means in their respective columns followed by the same letter are not significantly different from each other at P = 0 05

All values are averages of 4 replicates

Table 3. The influence of pod position relative to the canopy on the damage of cowpea pods by *Riptortus dentipes* and *Anoplocnemis curvipes* 1980-1981.

Cultivar	Average per pod		Average length of penduncles (cm)
	Feeding punctures	Damaged seeds	
Above canopy pods			
Tvu no 4596	6 40 a	4 63 a	17 62 a
Tvu no 4559	6 15 a	4 58 a	17 48 a
Average	6 28 a	4 61 a	17 55 a
Within canopy pods			
Tvu no. 4052	3.96 b	2 43 b	14 84 b
Tvu no 6641	4 18 b	2 26 b	15 27 b
Average	4 07 b	2 35 b	15 06 b

Means in their respective columns followed by the same letter are not significantly different from each other at P = 0 05

All values are averages of 4 replicates

indicating that this variety was less preferred for feeding than the other eight varieties tested side by side with it. The penduncle lengths of the cultivars listed in Table 2 were found to be highly correlated (r = + 0 89) with the number of seeds damaged per pod by the bugs. The experiments conducted in 1980 and 1981 to elucidate the role of pod position relative to canopy in cowpea resistances to the bugs showed that both Tvu nos 4596 and 6559 bearing pods held on penduncles above their canopies sustained significantly (P = 0.05) higher numbers of feeding punctures and damaged seeds per pod than Tvu nos 4052 and 6641 which produced pods that were concealed within their canopies (Table 3). The latter two cultivars also possessed significantly (P = 0 05) shorter penduncles which held the pods within the canopy thereby hiding them and consequently not being readily accessible to the bugs

Data presented in Table 4 shows that Tvu no 4052 which produced pods with smooth or even pod walls incurred significantly (P = 0.05) lower numbers of seeds damaged per pod than Tvu nos 4600 and 6627 which produced pods with uneven and ridged external morphology. These results (Table 4) suggest that evenness and smoothness in the external morphology of cowpea pods conferred some level of resistance to *R. dentipes* and *A. curvipes*. Other data obtained from measurements of pod wall thickness revealed that Tvu no 4052 possessed significantly (P = 0 05) thicker pod walls than Tvu nos 4600 and 6627 (Table 4) Tvu no 4052 which had thicker pod walls than the other two cultivars incurred significantly (P = 0.05) fewer feeding punctures (Table 4) indicating that it was more resistant to *R. dentipes* and *A. curvipes*.

Discussion

The bulk of the cowpea germplasm evaluated was apparently very susceptible to *R dentipes* and *A curvipes* with only a small portion being moderately resistant to the pests Indeed, other studies have indicated that this trend is common in cowpea germplasm with regard to its resistance to many of its pests (10, 11, 13, 17) This phenomenon is not peculiar in view of the fact that the existence of crop varieties immune to insect damage is a rarity (15) Besides, moderately resistant cultivars are known to occur more frequently among widely diverse germplasms of crops such as cowpea (1, 7, 8).

Table 4. **Influence of the external morphology of pods on their damage by *Riptortus dentipes* and *Anoplocnemis curvipes* 1980-1981.**

Cultivar	External morphology	Feeding punctures	Average damaged seeds/pod	Pod wall thickness (mm)
Tvu no 4052	smooth	3 36 a	2 3 a	0 94 a
Tvu no 4600	ridged	4 81 b	3 47 b	0 69 b
Tvu no. 6627	ridged	4 68 b	3.54 b	0 71 b

Means in their respective columns followed by the same letter are not significantly different from each other at P = 0 05

All values are averages of 6 replicates

The existence of moderate levels of resistance in cowpea germplasm to *R dentipes* and *A curvipes* can be explained by the fact that perhaps resistance is a product of several factors each of which conferred extremely low levels of resistance to the bugs For this reason it would be beneficial to breed for cumulative resistance by combining together different sources of low levels of resistance of each factor This strategy was suggested by Painter (7) and has yielded promising results in studies involving the cowpea curculio which is a serious pest of developing cowpea pods in the USA (3)

The observation that purple and dark-green pods were less damaged by the bugs than light-green pods can be explained by the fact that some insect pests can be attracted for feeding by the colour of the plant, flowers and fruits (1, 18) It was therefore concluded that light-green pods were more damaged than purple and dark-green pods by *R. dentipes* and *A curvipes* because they were more attractive to these notorious pests

Cowpea pods with uneven and ridged pod walls were more damaged than those with even and smooth pod walls by *R. dentipes* and *A. curvipes* apparently because their seeds were distinctly revealed by bulges and compressions, thereby making them to be easily accessible to the bugs It was also shown that pods with rugged external morphology possessed thinner pod walls suggesting that the seeds in them were located adjacent to the walls where they could easily be reached and damaged by the stylets of the bugs.

Finally the high correlation observed between the penduncle length and seed damage was mainly due to the fact that short penduncle held fruits within the canopy where they were presumably hidden from *R. dentipes* and *A. curvipes*. This factor is of considerable interest because it is also known to predispose cowpea cultivars to damage by *Maruca testulalis* Geyer (11, 12, 13).

Summary

Successful preliminary field evaluation of a diversified sample of world cowpea germplasm, consisting of 4022 cultivars, revealed that the bulk (99 18%) of them were susceptible to *Riptortus dentipes* (Fabricius) and *Anoplocnemis curvipes* (Fabricius) when judged on a 1-5 rating scale based on the degree of pod shrivel Thirty-three (0 82%) cultivars which sustained 20-39% and pod damage (PD) were considered moderately resistant and were selected for further field confirmation tests. Eight cultivars which exhibited reasonable levels of resistance to these bugs in replicated field trials were: Emma

B (22.5% PD), PS – 1 (36.7% PD), PS – 2 (33.2% PD), Katumani – 1 (22.2% PD), Tvu nos 6641 (25.6% PD), 4052 (21.8% PD) and 4339 (22.2% PD).

Further field tests showed that cowpea growth characters, namely; colour of fresh pods, external pod morphology, hull thickness, penduncle length and pod position relative to canopy contributed to the resistance of cowpeas to *R. dentipes* and *A. curvipes*.

Literature cited

1. BECK, S. D. Resistance to insects. Annual Review of Entomology 10:207-232. 1965.

2. BOOKER, R. H. Pests of cowpea and their control in Northern Nigeria. Bulletin of Entomological Research 55(4):663-672. 1965.

3. CUTHBERT, F. P., FERRY, R. L. and CHAMBLISS, O. L. Breeding for resistance cowpea curculio in Southern peas. Hort Science 9(1):69-70. 1974.

4. KHAEMBA, B. M. and KHAMALA, C. P. M. Relation of pod age to the expression of resistance in cowpea *Vigna unguiculata* (L.) to common pod sucking bugs *Riptortus dentipes* (F.) and *Anoplocnemis curvipes* (F.) (Hemiptera: Coreidae). Kenya Journal of Science and Technology (B) 2:79-83. 1981.

5. LE PELLEY, R. H. Agricultural insects of East Africa. Nairobi, Kenya, High Commission, 1959.

6. NYIIRA, Z. N. Pests of grain legumes and their control in Uganda. **In** Singh S. R., Van Emden H. F. and Taylor, T. A., eds., Pests of grain legumes: Ecology and Control. London, Academic Press, 1978.

7. PAINTER, R. H. Insect resistance in crop pests. New York, MacMillan, 1951. 520 p.

8. PATHAK, M. D. Genetics of plants in pest management. **In** Rabb, R. L. and Cuthrie, F. E. eds. Concept of pest management. Raleigh, North Carolina State University, 1970.

9. PHELPS, R. J. and COSTHUISEN, M. J. Insects injurious to cowpeas in Natal Region. Journal of the Entomological Society of South Africa 22:286-295. 1958.

10. SINGH, S. R. Cowpea cultivars resistant to insect pests in world cowpea germplasm collection. Tropical Grain Legume Bulletin 9:1-7. 1977.

11. SINGH, S. R. Resistance to cowpea pests in Nigeria. **In** Singh, S. R., Van Emden, H. F. and Taylor, T. A. eds. Pest of Grain Legumes: Ecology and Control. London. Academic Press. 1978.

12. SINGH, S. R. and ALEN, D. J. Cowpea pest diseases. Ibadan, Nigeria. International Institute of Tropical Agriculture. Manual series No. 2. 1979.

13. SINGH, S. R. and TAYLOR, T. A. Pests of grain legumes and their control in Nigeria. **In** Singh, S. R., Van Emden, H. F. and Taylor, T. A. eds. Pests of grain legumes: Ecology and Control. London. Academic Press. 1978.

14. SINGH, S. R. and VAN EMDEN, H. F. Insect pests of grain legumes. Annual Review of Entomology 24:255-278. 1979.

15. SNELLING, R. O. Resistance of plants to insect attack. Biological Review 7:543-586. 1941.

16. TAYLOR, T. A. The effects of insecticide applications on insect damage and performance in cowpea in Southern Nigeria. Nigeria Agricultural Journal 5:29-30. 1968.

17. TODD, J. W. and CANARDAY, T. D. Resistance of southern peas to cowpea curculio. Journal of Economic Entomology 61:1 327-1 329. 1968.

18. THORSTENSON, A. J. Host selection in Phytophagous insects. Annual Review of Entomology 5:193-218. 1960.

Reseña de libros

TERGAS L. E. El Potencial del Pasto King Grass, como gramínea forrajera seleccionada para América Tropical. CIAT, Colombia, 1984. 34 p

Esta publicación trata de las primeras experiencias obtenidas con el pasto King Grass en países como Panamá, Cuba y Colombia

En primer lugar, se refiere a aspectos relacionados con los orígenes, la taxonomía y la problemática que ha existido con relación a forrajes y describe morfológicamente el King Grass, recalcando su parecido con la caña de azúcar

Posteriormente se analizan las características en cuanto a adaptación de dicha gramínea. Se hace referencia a la diversidad de climas y suelos que puede tolerar, ya que se adapta bien en tierras altas (hasta 2 000 metros sobre el nivel del mar) de mediana fertilidad, así como en suelos bajos con períodos secos muy prolongados y además soporta un amplio rango de acidez de los suelos.

En lo que respecta al establecimiento, se indican aspectos técnicos importantes como lo son: la preparación de suelos, distancias de siembra, selección de la semilla vegetativa y cantidad requerida por hectárea y edad recomendable para hacer el primer corte después de la siembra. Se discuten además, los incrementos que se pueden obtener de materia seca al aplicar fertilizantes, principalmente fuentes nitrogenadas.

Se anotan también los resultados de un ensayo en el que se estudió el efecto de tres niveles de fertilidad del suelo sobre la productividad estacional bajo corte del King Grass y el merker (*Pennisetum purpureum*). En todos los niveles la producción de materia seca fue mayor para el King Grass

Un aspecto que no queda muy claro y que sería conveniente ampliar posteriormente, es el que tiende a demostrar que el King Grass no es una especie forrajera que responda bien a la fertilización del suelo, pues solamente se logró un incremento del 23 6% en los rendimientos al nivel más alto de fertilización al compararlo con un testigo

El siguiente aparte, que se refiere a su composición química y valor nutritivo, indica que en estos aspectos el King Grass es muy similar a otras gramíneas tropicales. La edad de la planta y la fertilidad natural del suelo son factores que determinan su composición química. En cuanto al valor nutritivo, que no está dado por la composición química sino que por la digestibilidad de la materia seca y el consumo voluntario, los resultados que se dan son muy parecidos a los de otras gramíneas. En términos generales, de acuerdo a la composición química, el King Grass se podría calificar como un forraje de calidad aceptable, excepto por ciertas deficiencias en P y Ca

Con relación a la suplementación con leguminosas para mejorar la calidad del forraje, en especial el uso de *Leucaena*, la obra indica que la adición de esta leguminosa, hasta un nivel del 40% de la dieta, contribuye a aumentar sustancialmente la proteína cruda y disminuir el nivel de fibra, pero no afecta los niveles de P, Ca y lignina

El capítulo que se refiere a la conservación de forrajes, recoge las experiencias preliminares obtenidas en microsilos de King Grass en Panamá, en los que se usó diferentes proporciones de melaza y urea como aditivos, comparados con un testigo. Este último presentó un pH de 4 2, con características de un buen ensilaje, mientras que los tratamientos con urea presentaron valores de pH más elevados y con un fuerte olor amoniacal

El último aspecto que cita el documento es el relativo a la productividad animal, en el cual los datos son escasos y sólo se indica que la producción de leche por vaca por día puede aumentarse de 3 28 kg con ensilaje de King Grass sin suplementación a 6 04 kg con el mismo ensilaje suplementado con 1 5 kg de melaza, 2% urea y 10% harina de pescado.

En conclusión, la información contenida en este boletín es importante pues viene a ampliar los pocos datos disponibles en nuestro país referentes al King Grass, el cual ha tenido una difusión tan amplia que prácticamente está reemplazado a los pastos tradicionales de corte como el Imperial (*Axonopus scoparius*) y los gigantes (*Pennisetum purpureum*)

MAURICIO E GOMEZ HERNANDEZ
ASISTENCIA TECNICA
BANCO NACIONAL DE COSTA RICA