Studies on aspects of the bionomics and pest status of *Piezotrachelus varius* Wagner (Coleoptera: Curculionidae) on cowpea (*Vigna unguiculata* (L) Walp in the Western Derived Savanna Zone of Cameroon.

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ABSTRACT

Studies were conducted on the population fluctuations of the cowpea pod weevil, *Piezotrachelus varius* on cowpea at Melong, Nyokon and Babessi, and the susceptibility of seeds of selected cowpea cultivars to its damage in the western derived savanna zone of Cameroon, during the 1999 and 2000 cowpea cropping seasons. Results showed that 1-2 *P. varius* adults/plant were found on cowpea plants during the pre-flowering stage but increased at flowering and pod filling stages to a peak of 11 adults/plant at pod maturity. In the laboratory, adults continued to emerge daily within two weeks of storage of harvested pods. There were no significant differences in the duration of *P. varius* development on the different cowpea varieties tested. The developmental period from egg to pupation and mean pupal duration ranged from 10.4-11.1 days and 6.3-6.7 days, respectively. The total developmental period (egg – adult) on all tested cowpea varieties ranged from 16.6-17.7 days. Field evaluations of the damage to cowpea seeds by *P. varius*, showed that all cultivars screened were susceptible; the degree of seed damage varied with cowpea cultivars. The overall seed damage by *P. varius* at Melong was =50%, on Melong local, Foumbot local, IT90k-59, TVu13740 and IT87D-1676 cowpea cultivar while that on TVu3236, MTA 22 and Babessi local was < 50%. Seed damage was considerably lower at Babessi than at Melong, with no variety having > 12% damage. The number of *P. varius* that emerged from infested pods of the different cowpea cultivars in storage, was positively co-related with the percentage of damaged seeds.

Keywords: *Piezotrachelus varius,* Population dynamics, cowpea varieties, seed damage

RÉSUMÉ

Des études ont été menées sur la fluctuation des populaions du charançon de la gousse de niébé, *Piezotrachelus varius,* sur de niébé à Melong, Nyokon et Babessi, ainsi que sur la susceptibilité des graines de cultivars sélectionnés de niébé aux dommages dus à ce ravageur dan la zone de savane de l'Ouest de Cameroun, pendant les saisons culturales de 1999 et 2000. Les resultats ont montré que de 1 à 2 adultes de *P. varius* étaient recouvrés des plants de niébé pendant la phase pré-florale; cepandant leaur nombre augmentait à floraison et lors de la phase de remplissage des gousses, pour atteindre un pic de 11 adultes par plant à maturité des plants. Des adultes ont continué d'émerger quotidiennement en laboratoire, jusqu'à deux semaines après stockage des gousses récoltées. Il n'y avait pas de différences de durée de développement de *P. varius* signigicatives sur les différentes variétés de niébé testées. La période de dévelopment des oeufs jusqu'à pupation et la durée moyenne du stade pupaire étaient de 10.4-11.1 et 6.3-6.7 jours respectivement. La période totale de développement (oeufs-adulte) sur toutes les variétés de niébé testés était de 16.6-17.7 jours. Des évaluations de dommage aux graines de niébé dus à *P. varius* en champs ont montré que tous les cultivars criblés étaient susceptibles; le taux d'endommagement de la graine variait avec le cultivar de niébé. A Melong, le taux total d'endommagement des graines par *P. varius* sur les cultivars de niébé Melong local, Foumbot local, IT90k-59, Tvu13740 et IT87D-1676 était ≥50%, tandis qu'il était <50% sur Tvu 3236, MTA 22 et Babessi local. L'endommagement des graines était considérablement plus bas à Babessi qu'à Melong, avec aucune variété ne présentant des dommages >12%. Le nombre de *P. varius* adultes qui ont émergé des gousses des différents cultivars de niébé en magasin était positivement corrélée au taux de graines endommagées.

Mots clés : Piezotrachelus varius, dynamique des populations, vigna unguiculata, semances

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INTRODUCTION

Cowpea, *Vigna unguiculata (L)* Walp, is widely grown in the subtropics and tropics. It is one of the main sources of plant proteins in Africa (Okigbo, 1978). The shelled green or dried seeds, tender green pods and tender leaves used as vegetables are widely consumed in the tropics (Rachie, 1985). In Cameroon, the dry seeds are prepared as porridge, and also as a traditional steamed caked (called 'khoki') wrapped in plantain leaves. The crop is also useful as a green manure and as a source of fodder for animals. The tendency of indeterminate cultivars to produce pods over a long period makes cowpea a suitable crop for subsistence (Duke, 1990)

Despite the variety of uses of the crop, cowpea grain yields in Africa are usually very low and range from between 240 and 300kg/ha (Rachie, 1985). Among the factors responsible for these low yields, are insect pests (Singh *et al.*, 1990). The crop is attacked from seedling to harvest by several insects belonging to several phytophagous taxa. In spite of the high insect pest diversity that inflicts damage on cowpea at various growth stages, those that damage the developing and mature seeds are likely to be of greater economic importance, because cowpea is usually grown for its grains (Dreyer and Baumgärtner, 1995). Some of the most important pod and seed pests of the crop include some coleopteran larvae and various species of heteropteran pod sucking bugs (PSB). One of the major coleoptran seed pest of cowpea in Cameroon is the cowpea pod weevil, *Piezotrachelus varius* Wagner [syn. *Apion varium* Wagner] (Coleoptera: Curculionidae). It has also been reported as a pest of cowpea in Benin Republic (Dreyer *et al* 1994), and it causes high seed yield losses on cowpea in Senegal (Ndoye, 1978) and in Nigeria where grain losses as high as 92 % have been reported (Jackai and Daoust, 1986). It therefore appears that *P. varius* is becoming a regional problem of cowpea production in West Africa.

Despite reports of *P. varius* being a pest of cowpea in the Western Highlands of Cameroon (Bapfubusa *et al.*,1990; Parh, 1999; Edimengo, 2000), there is scanty information on its population variation with cowpea crop phenology, the susceptibility of seeds of cowpea varieties to its damage and the yield losses of cowpea due to its damage. Therefore the main objectives of this study were to:

1) study the population variation of *P. varius* with cowpea phenology;
2) evaluate selected cowpea varieties for their susceptibility to damage by *P. varius* and
3) assess seed damage caused by *P. varius* on various cowpea varieties.

MATERIALS AND METHODS

Studies on population variation with crop phenology-

These studies were carried out in farmers' fields at Babessi, Foumbot, Nyokon and Melong. Data on the global positioning system (GPS) of these sites are shown in Table 1. In each site, 5 farmers were selected and agreements made with them for their fields to be used for the studies. Each selected farmer's field was at least 0.5ha and was cultivated and planted by the farmers with the most popular local cowpea variety of each locality. The crops were grown under the traditional farming practices of the area. At the pre-flowering stage, 16-20 days after planting (DAP), three experimental subplots of 10m x 10m were marked out in each farm for sampling of *P. varius*. Sampling was by in-situ visual counts carried out between 08.00-11.00 a.m. when most adults of *P. varius* usually bask on the pods

Table 1: The Global Positioning System (GPS) data for Babessi, Foumbot, Melong and Nyokon in the Western derived Savanna Zone of Cameroon.

Site	Latitude	Longitude	Altitude
Babessi	05^0 59' 26"N	10^0 32' 38"E	1203m
Foumbot	05^0 27' 66"N	10^0 34' 09"E	1045m
Melong	05^0 09' 31"N	09^0 58' 81"E	736m
Nyokon	05^0 54' 29"N	11^0 59' 39"E	842m

and crop canopy. By walking gently between the rows, records of any *P. varius* observed on the cowpea pods, leaves and branches were made on a form. The crops in each experimental subplot in each field were sampled again at between 28-35 DAP (flowering), 48-55 DAP (pod filling stage) and at 70-75 DAP (pod maturity). At harvest, (85-95 DAP), 100 pods were randomly collected from each experimental subplot and used to asses grain damage, and also count the number of *P. varius* adults that emerged from them after harvest.

Evaluation of cowpea susceptibilities to P. varius.
This was done both in laboratory experiments at the University of Buea and in field trials at Babessi and Melong study site. The five improved cowpea varieties used in this study were; IT87D-1676,TVu 13740,TVu 3236, IT90K-59 and MTA 22 from the International Institute of Tropical Agriculture (IITA), Ibadan, while the three local varieties used were Foumbot local, Babessi local and Melong local. The local varieties were obtained from local markets in Cameroon. For the field experiments, the cowpea varieties were planted during the first and second cropping seasons in experimental plots that measured 10 x 8m. The seeds were sown at the rate of 2 seeds/hill, and at 50cm and 25cm between and within rows respectively. The crops were weeded at 30 DAP and 50 DAP. At the pod developmental stage, 2-5 intact pods on the plant were enclosed in a mesh bag of 20 cm x 15cm, provided with a 30cm, string to fasten it around the pod peduncle. These pods were then infested with 5 pairs of feral adults of *P. varius* and observed daily for oviposition punctures on the pods for a period of 15 days. Pods with oviposition punctures were harvested, transferred to the laboratory and kept in petri dishes at ambient conditions (23 ± 7^{0}C and $70\pm10\%$ relative humidity). These were observed daily till pupation, and later, to adult emergence, in order to record the duration of development of *P. varius* from eggs to pupation and the total developmental period from egg to adult on each cowpea variety. Pods were changed whenever they started to rot. The experiment was replicated 20 times on each cowpea variety. For the field experiments, the same cowpea varieties were planted in one location at the Babessi and Melong sites to allow for natural field infestations of plants by *P. varius*. Each variety was planted in experimental plots of 10m x 8m. Sowing was done at 2 seeds/hill and at 50cm and 30cm between and within rows respectively. The distance between experimental plots was 2 metres. There were 4 replicates per variety. At the pre-flowering, flowering, 50% podding and pod maturity stages, adults of *P. varius* were sampled on the crops by visual counts in order to assess its field infestations of the crop. At the pod filling stage, the numbers of feeding punctures on pods were counted on 30 pods/plot. At harvest, 100 pods per plot were randomly collected for assessment of grain yields and the record of the number of adults of *P. varius* emerging from them within two weeks after harvest.

Assessment of cowpea seed damage
The cowpea seed damage by *P. varius* was done by use if 100 cowpea pods collected per farmer's field from the various sites mentioned earlier, and those collected from the experimental plots set up at Babessi and Melong. In each case, the harvested pods were stored for two weeks in mesh screened cages in the laboratory in order to complete the drying of the pods. During this period, all adults of *P. varius* that emerged per set of pods were counted. At the end of this period when adult emergence stopped, the pods were opened and the number of seeds per pod counted. The seeds damaged by *P. varius* were counted and separated on the basis of the damage characteristics described by Parh (1999). Similarly, seed damaged symptoms of *P. varius* were based partially on the damage characteristics described by Parh (1999) for *Apion* sp and those described in the results of this study.

RESULTS

Variation of P. varius population with crop phenology
Generally, the number of *Piezotrachelus varius* adults on the plants varied with the study site. The highest number on plants was recorded at Melong and lowest at Babessi.

However, irrespective of the site, isolated *P. varius* adults appeared on cowpea foliage at the pre-flowering stage (16-20DAP) and fed on the leaves. This population gradually increased during the flowering stage (28-35DAP) with the adults still feeding mainly on the leaves and occasionally on the flowers. The population increased significantly at pod filling (48-55DAP) when feeding was concentrated on pods. The insects fed mainly on the

Table 2: Mean number (±se) of *Piezotrachelus varius* adults sampled per cowpea plant in the different sites at different growth stages expressed in days after planting (DAP)

Site	16-20DAP	28-35DAP	48-55DAP	70-75DAP
Babessi	0.06±0.02	0.00±0.00	0.07±0.01	0.19±0.03
Foumbot	0.00±0.00	0.06±0.01	0.73±0.13	0.92±0.06
Melong	0.21±0.02	2.90±0.28	6.34±0.27	11.41±0.83
Nyokon	0.00±0.00	2.66±0.48	3.05±0.95	4.33±0.93

mesocarp of the pods, and their feeding led to rugged feeding punctures on the pods. The population peaked at pod maturation stage (Table 2) and gradually decreased as the pods got dry. Within two weeks of storage of harvested pods from a heavily infested site like in Melong, a mean number of 2 adults emerged per pod and in some cases up to 6-7 adults emerged per pod.

Evaluation of cowpea varieties for resistance to P. varius

Laboratory antibiosis evaluation of cowpea varieties showed that *P. varius* developed normally on all the varieties tested. The developmental period from eggs to pupation ranged from 10.4-11.1 days and the mean pupal duration from 6.3-6.7 while the total developmental period ranged from 16.6-17.7 days on all the varieties tested (Table 3). Adults that emerged from pupae were not deformed irrespective of the cowpea variety. This indicates that none of the cowpea varieties that were used in this study was resistant to *P. varius*. In the field evaluation, some pods of all varieties had feeding punctures on the pod walls. The number of punctures per pod varied with the variety and location. In Babessi, the variety, IT90K-39 had the highest number of punctures with an average of 7 holes per pod while at Melong, the variety, 'Babessi local' had the highest number of punctures with a mean of 11 holes per pod (Table 4).

Table 3: Duration of development of *Piezotrachelus varius* from egg to pupa, pupal and total development on pods of different cowpea varieties under laboratory conditions.

	Duration in days (±se)		
Cowpea variety	**Egg-pupa**	**Pupal**	**Total development**
IT87D-1676	10.35±0.06	6.33±0.08	16.60±0.13
TVu-13740	10.66±0.12	6.28±0.02	16.94±0.13
TVu-3236	10.91±0.70	6.65±0.10	17.56±0.17
IT90K-59	11.10±0.16	6.60±0.12	17.69±0.14
MTA 22	10.73±0.06	6.41±0.10	17.14±0.18
Foumbot local	10.92±0.13	6.48±0.14	17.40±0.19
Babessi local	10.78±0.07	6.61±0.09	17.39±0.07
Melong local	10.93±0.11	6.73±0.12	17.38±0.18

Table 4: Cowpea pods/seeds damage parameters and the number of *Piezotrachelus varius* adults that emerged per 100 pods of different cowpea varieties harvested from experimental plots at Melong (M) and Babessi (B) sites.

Variety	Study Site	Mean No. of holes/pod	No. of *P. varius.* adults	No. of seeds	No. damaged	Percent damaged
IT87D-1676	M	11.3±0.62	144	533	383	71.65
	B	2.0±0.01	58	1040	110	10.57
TVu-13740	M	8.7±0.95	242	816	424	51.96
	B	1.0±0.00	33	1111	47	4.23
TVu-3236	M	10.2±0.46	93	577	288	49.91
	B	2.0±0.02	17	97	13	1.32
IT90K-59	M	9.9±1.11	269	720	583	80.97
	B	7.6±0.88	28	1065	25	2.34
MTA 22	M	8.1±0.47	79	693	340	49.06
	B	1.0±0.4	39	961	29	3.01
Foumbot local	M	5.2±0.67	105	543	390	71.82
	B	4.3±0.88	27	906	20	2.21
Babessi local	M	11.5±0.70	112	493	232	47.05
	B	6.0±1.02	23	1208	20	1.65
Melong local	M	8.3±0.92	215	593	498	83.97
	B	6.2±1.05	38	1136	27	2.37

Cowpea seed damage

Cowpea seeds that are damaged by *P. varius* are characterised by the presence of one or more rugged holes on them as well as feeding galleries within the seeds. Completely damaged seeds were often surrounded by frass, and the adjacent damaged seeds in the pods are terminally glued together, with some frass superimposed on the seeds to make them appear slightly larger. Often there was also the presence of the pupa(e) or a left-over pupal case(s) in the seeds.

Table 5. Percentage of cowpea seeds damaged by *Piezotrachelus varius* from pods harvested from farmers' fields in the Western Derived savannah of Cameroon.

Site	**Total No. of seeds**	**No. damaged by *P. varius***	**Percentage damaged seeds**
Babessi	218	15	6.88
Foumbot	408	5	1.23
Melong	572	465	81.29
Nyokon	486	236	48.66

For the evaluation of cowpea seed damage in farmers' fields, each of the most popular cultivar grown at Babessi, Foumbot, Nyokon and Melong was susceptible to damage by *P. varius* at various degrees. The percentage of seeds damaged varied from one site to another. The highest percentage (83.97%) was recorded at Melong and the lowest (1.23%) was at Foumbot (Table 5). The percentage of seeds damaged from each site was positively co-related with the number of *P. varius* adults that emerged, r^2 being 0.69 and 0.78 respectively for the Melong and Babessi study sites.

For the varietal screening, all varieties tested were susceptible to *P.varius* seed damage at various degrees. The cultivars/varieties, Melong local, Foumbot local, IT90K-59, TVu13740 and IT87D-1676 had = 50% seed damage in Melong while TVu 3236, MTA 22 and Babessi local had < 50% damage in the same site. The seed damage was considerably lower at Babessi with no variety or cultivar having more than 12% damage. The percentage was positively co-related with the number of insects that emerged in storage across varieties/ cultivars.

DISCUSSION

Isolated *P. varius* appearing on cowpea at the pre-flowering stage is constant with previous findings that the weevil can also be found on different sites of the plant (Knobel, 1988). This also suggests that the insect must have survived the cowpea off-season on alternate host plants within the agroecozone. This confirms the findings of Edimengo (2000), who observed that the adults of *P. varius* were found on a number of plants other than cowpea during the cowpea off-season. The population of the pest increased significantly at the cowpea pod filling stage because young green pods are preferred to older pods for oviposition (Booker, 1965). The population of adults of *P. varius* peaked on cowpea plants at the pod maturation stage. This was probably so because the offspring of the adults of *P. varius* that colonised the plants earlier had developed to neonate adults on the pods since the total developmental period for the insect was around 16-18 days.

There were no significant differences in the total developmental period of *P. varius* on the various cowpea varieties that were screened. This implies that, none of these varieties exhibited significant antibiotic effects on the pest (Painter, 1951). Similarly, since all these varieties were normally infested by *P. varius* in the field trials, it is therefore evident that none of them exhibited significant antixenotic resistance (Kogan and Ortman, 1978). However, based on the results of the grain damage assessment, it is evident that the varieties, TVu 3236, MTA 22 and Babessi local exhibited some degree of tolerance vis-à-vis seed damage by *P. varius* because they had < 50% grain damage at Melong where the insect population was usually higher than at Babessi where the crop is less colonised in comparison to the other sites. These apparently tolerant varieties could be used together with other components of pest control strategies such as the use of natural enemies in an IPM system. This however requires further studies. The use of natural enemies (both disease and arthropod organisms) against *P. varius* seems promising because natural enemies can get to the hidden developmental stages of the life cycle of the insect by exploiting the feeding punctures created on the pods walls. Edimengo (2000) identified five hymenopteran parasitoids that emerged together with *P. varius* from cowpea pods collected from farmer's fields. This however, requires further study for possible exploitation together with the tolerant varieties.

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