# Insect Pest Incidence on Cowpea in the Cameroonian Southwest Forest and Western Derived Savanna Zones, their Contribution to Yield Loss in Foumbot and their Control.

I.A. Parh*

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## Summary

*In 1986 and 1987, insect pests sampled on cowpea in the Cameroonian Southwest forest and Western derived savanna ecological 1 zones included* Maruca vitrata, Leguminivora (Cydia) ptychora, Helicoverpa (Heliothis) armigera, Melanagromyza vignalis, Apion disjunctum, Aphis craccivora, *heteropteran bugs and bruchids. Under eight different deltamethrin spray schedules evaluated for their control at Foumbot, western derived savanna ecozone, the yield loss they caused ranged from 123.60 kg/ha in plants sprayed twice at the reproductive stage to 362.51 kg/ha in unsprayed plants in 1988; 21.86 kg/ha in plants sprayed thrice at the reproductive stage to 90.73 kg/ha in unsprayed plants in 1989 and 91.72 kg/ha in plants sprayed 5 to 6 times at fortnightly intervals, to 184.08 kg/ha in unsprayed plants in 1990. The percentage loss due to* Maruca vitrata, Melanagromyza vignalis *and heteropteran bugs was high in sprayed and unsprayed plots. In 1989 and 1990, seed yields were significantly increased by spraying deltamethrin either forthnightly, or once at 75-100% flowerbuds and once at 75-100% podding, or once at 75-100% flowering and once at 75-100% podding.*

## Résumé

*Des investigations menées au Cameroun en 1986 et 1987 sur niébé en zone forestière du Sud-Ouest et en savane dérivée de l'Ouest ont permis de recenser sur cette culture outre des hétéroptères et les bruchidae,* Maruca vitrata, Leguminivora (Cydia) ptychora, Helicoverpa (Heliothis) armigera, Melanagromyza vignalis, Apion disjunctum, Aphis craccivora. *Des essais effectués à Foumbot, zone de savane dérivée de l'Ouest avec de la deltamethrine selon huit différents traitements pour le contrôle de ces ravageurs donnent une indication de l'impact de cet insecticide sur le rendement. En 1988 on a enregistré des pertes de production de 123,60 kg/ha sur parcelles traitées 2 fois durant la phase de reproduction contre 362,51 kg/ha sur les non traitées. En 1989, trois traitements durant la même phase phénologique ont amené à une perte de 21,86 kg/ha sur parcelles traitées contre 90,73 kg/ha sur non traitées. Ces pertes étaient en 1990 de 184,08 kg/ha sur parcelles non traitées, contre 91,72 kg/ha sur les plantes ayant subi 5 à 6 traitements de trois semaines après semis à 10 jours avant récolte. Les applications de deltamethrine soit 5 à 6 traitements durant le cycle de la plante, soit deux fois dont une fois à 75-100% de formation boutons floraux et une fois 75-100% de fructification ou encore une fois à 75-100% de floraison et une fois à 75-100% de fructification ont permis d'obtenir un accroissement significatif du rendement.*


## Introduction

Cowpea, *Vigna unguiculata* (L) Walp, is extensively cultivated in the southwest forest, western derived savanna and northern savanna ecological zones of Cameroon. Parh (8) showed that in the southwest forest zone, it is sown along river basins in mid November/December of each year and in mid September/early October of each year in the western derived savanna zone. Cowpea is an important source of plant protein for the people in these two ecological zones because most farm families commonly prepare and eat it in many different forms. It is an important source of income for them also because as at January 1997, the farm-gate cost of a 100 kg bag of cowpea seeds ranged from 23300-33000 F.CFA (US $ 48.00-68.00) depending on availability in the local markets.

Very little research has however been conducted to document both the spectrum of cowpea insect pests in the southwest forest and western derived savanna zones of Cameroon and the level of yield loss these pests cause in cowpea in these ecozones. The present work was therefore conducted to:

1. Document the spectrum of insect pests associated with cowpea in the two ecological zones,
2. Identify insect key pests that directly damage cowpea seeds at Foumbot, which is one of the locations of intensive cowpea cultivation in the Cameroonian western derived savanna zone and,
3. Evaluate the effect of different deltamethrin spray schedules on cowpea seed yields at Foumbot.

* Department of Plant Protection, Faculty of Agriculture, University of Dschang, P.O. Box 308, Dschang, Cameroon.

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## Material and Methods

### Insects associated with cowpea in the southwest forest and western derived savanna ecozones

A survey to document insects associated with cowpea in the southwest forest and western derived savanna ecological zones of Cameroon was conducted from November 1986 to October/November, 1987. The survey sites chosen in each ecological zone were among the sites where cowpea is intensively cultivated each during the cropping season. Two out of six and four out of twelve sites were chosen randomly among the potential sites in the southwest forest zone and western derived savanna zone respectively. The sites in the forest zone were Badun and Njombe villages. Those in the western derived savanna zone were Melong, Foumbot, Babungo and Befang villages.
In each survey site, three farms in which insects were sampled during the cowpea growing season were randomly chosen. The insects were sampled fortnightly by use of a sweepnet. Each sample comprised 50 sweeps. Insects were sampled also by visual observation. Flowers and pods were sampled also in order to identify and document insects that damage directly, cowpea flowers, pods and seeds. The insects sampled at each site, were all put in a sampling bottle containing 70% alcohol and transported to the laboratory, where they were identified. Specific identification of some unidentified insects was done at the British Museum, London, United Kingdom. The insects sampled and the respective type of damage they cause on the crops were recorded.

### Justification of the use of deltamethrin

Deltamethrin was used in this study because it is a relatively safe insecticide but very effective against arthropods at very small doses and Parh (8) had demonstrated its efficacy in the control of cowpea insect pests in Cameroon. It was therefore used to protect plants whose yields were compared with those of unprotected plants. Yield loss due to damage by seed insect pests was subsequently based on the difference between yields from protected plants and that from unprotected plants.

### Study site

Studies were conducted on yield loss in 1988, 1989 and 1990, at the Institute of Agronomic Research (I.A.R.) Station in Foumbot.

### Cowpea cultivars used

The five cowpea cultivars used in the study: MA 2/1, a medium duration cultivar of the International Institute of Tropical Agriculture disseminated in Cameroon and harvestable at 75-85 days after planting (d.a.p.), and four local cultivars named after their respective villages of acquisition: Foumbot local and Befang local (both medium duration) and Badun local and Melong local, both long duration and harvestable at 85-95 d.a.p.

### Experimental design and sowing

In this study, the split-plot experimental design was used. The crop was sown each year in five blocks and each block measured 35.0 x 14.5 m. The eight main treatments in each block were the deltamethrin insecticide spray schedules while the five cowpea cultivars were the sub-treatments. In each of the eight main plots measuring 14.5 x 3.0 m, each cowpea cultivar was sown in a subplot measuring 3.0 x 2.1 m.The seeds were sown on the flat at the rate of three seeds per hole, and at 70.0 cm between rows and 25.0 cm within rows. The plants were thinned to one per stand at 20 d.a.p. to give 13 plants per row and a total of 57143 plants/ha. The distance between the main plots, the cowpea cultivars within the main plots, and the blocks were 1.5, 1.0 and 2.0 m respectively.

The deltamethrin insecticide was used at 12.5 g a.i/ha and a "solo" pneumatic Knapsack sprayer was used to apply insecticide under different spray schedules. In each replicate, the following spray schedules (main treatments) were randomly assigned to any of the eight main plots that was sown to the five cowpea cultivars (sub-treatments):

1. No deltamethrin insecticide spraying (control).
2. Spraying fortnightly with deltamethrin, from 21 d.a.p. to 10 days before harvest (d.b.h.), giving five sprays for Foumbot local, Befang local and MA 2/1 cultivars and six sprays for Badun local and Melong local cultivars.
3. Spraying once at 75-100 flowerbuds, once at 75-100% flowering and once at 75-100% podding stages. These corresponded to spraying once at 45, 55 and 75 d.a.p. for Foumbot local, Befang local and MA 2/1 cultivars respectively, and 55, 65 and 80 d.a.p. for Badun and Melong local cultivars respectively. This gave three insecticide spray applications.
4. Spraying once at 75-100% flowerbuds and once at 75-100% flowering (two sprays)
5. Spraying once at 75-100% flowerbuds and once at 75-100% podding stages (two sprays)
6. Spraying once at 75-100% flowering and once at 75-100% podding stages (two sprays)
7. Spraying once only at 75-100% flowering (one spray)
8. Spraying once only at 75-100% podding stage (one spray).

### Harvesting of cowpea pods and shelling

In each main plot, cowpea pods of each cultivar were harvested from 20 plants in the two middle rows of the four rows of plants receiving any of the above eight treatments. All pods were hand-shelled.

### Recognition of damage caused by each seed insect pests

Seeds completely damaged by seed insect pests and thereby uneatable or unsaleable were separated from healthy seeds during shelling. The damaged seeds were further separated and classed on the basis of recognizable damage symptoms attributable to each seed insect pest as follows:

1. *Maruca vitrata:* Pods have soiled holes with exuding soiled frass at the point of larval entry into the pods; remains of seeds fel on are soiled to a dark brown colour.
2. *Leguminivora (Cydia) ptychora:* Seeds which are fed on inside pods, have holes with frass exuding from

the holes on seeds.

3. *Helicoverpa armigera:* Larval entry holes on infested pods are large, unsoiled and without frass; remains of seeds fed on are clean and unsoiled.
4. *Aphis craccivora:* Colonised pods are blackened because of honey dew produced by the aphids; seeds of heavily colonised pods are completely blackened and unsaleable.
5. *Apion disjunctum:* Infested seeds inside pods have several rugged holes and completely damaged seeds are terminally glued together in the pods.
6. *Melanagromyza vignalis:* Seeds the larvae infest in pods usually have pin-holes at the extremities and have also both external and internal soiled galleries.
7. *Heteropteran bugs:* Infested pods have collapsed cells and constriction at the points of the feeding puncture of the bugs and young seed fed upon in pods usually abort.
8. *Bruchids:* Infested seeds inside pods have the characteristic round exit holes of bruchids.

The seeds damaged by each seed insect pest species in each subplot in the main plot, were counted in order to obtain the contribution of each species of pest to yield loss.

### Assessment of seed yield loss

In this study, loss in seed yield was based only on seeds lost due to feeding damage on seeds by different seed insect pests. For each cowpea cultivar under each spray schedule, five hundred undamaged seeds were weighed in order to obtain the mean weight (g) of undamaged seeds. The losses due to completely damaged seeds were obtained by multiplying the total number of insect damaged seeds by the mean weight of an undamaged seed. Seed yield loss due to damage by seed insects was then obtained by converting weight losses in kg/ha. Loss from the five cowpea cultivars used in each main plot were confounded and used to assess loss under different spray schedules.
The mean percentage yield loss contributed by each seed insect pest species, was calculated for each cowpea cultivar under each spray schedule, by use of the formula:

Lsy = (ws/WS) x 100, where,

Lsy = % loss in seed yields;
ws = weight of seeds completely damaged by each particular seed insect species;
WS = total weight of seeds completely damaged by all seed insect pest species.

### Yields of healthy seeds

The yields (kg/ha) of healthy seeds from the five cowpea cultivars used in each main plot were confounded. These confounded yields were used to evaluate the different spray schedules. The mean yield (kg/ha) under each spray schedule, was the average yields from the five cultivars.
The mean loss in yield (kg/ha) and the mean healthy seed yield (kg/ha) under the different spray schedules, were analysed by use of analysis of variance. The means were separated by use of Duncan multiple range test at the 5% level of significance.

**Table 1**
**Species of insects sampled on cowpea plants at different sites in the southwestern forest and western derived savanna zones of Cameroon in 1986 and 1987.**

| Insect species observed on plants in both ecozones | Destructive stage* | Damage caused on plants |
|---|---|---|
| *Alcidodes* spp. (Col.: Curculionidae) | A | Girdle stems, roots & pods |
| *Apion disjunctum* Wagner (Col.: Curculionidae) | L | Mine fresh seeds internally |
| *Hyperacantha humilis* Fairmaire (Col.: Chrysomelidae) | A | Defoliation |
| *Lamprocopa* spp. (Col.: Chrysomelidae) | A | Defoliation |
| *Medythia quaterna* (Col.: Chrysomelidae) | A | Defoliation |
| *Ootheca* spp. (Col.: Chrysomelidae) | A | Defoliation |
| *Podagrica uniformis* Jacoby (Col.: Chrysomelidae) | A | Defoliation |
| *Lagria* spp. (Col.: Tenebrionidae (Lagriidae) | A | Defoliation |
| *Callosobruchus* spp. (Col.: Bruchidae) | L | Bore drying seeds |
| *Anoplocnemis curvipes* Fabricius (Het.: Coreidae) | A&N | Suck sap from tender pods & seeds |
| *Clavigralla horrida* Germar (Het.: Coreidae) | A&N | Suck sap from tender pods & seeds |
| *Riptortus dentipes* Fabricius (Het.: Alydidae) | A&N | Suck sap from tender pods & seeds |
| *Aspavia armigera* Fabricius (Het.: Pentatomidae) | A&N | Suck sap from tender pods & seeds |
| *Nezara* spp. (Het.: Pentatomidae) | A&N | Suck sap from tender pods & seeds |
| *Empoasca dolichi* Paoli (Hom.: Cicadellidae) | A&N | Suck sap from tender stems & leaves |
| *Empoasca barbistyla* Paoli (Hom.: Cicadellidae) | A&N | Suck sap from tender stems & leaves |
| *Aphis craccivora* Koch (Hom.: Aphididae) | A&N | Suck sap from stems, leaves & pods |
| *Megalurothrips sjostedti* Trybom (Thysan.: Thripidae) | A&N | Suck sap from flowers |
| *Sericothrips occipitalis* Hood (Thysan.: Thripidae) | A&N | Suck sap from flowers & leaves |
| *Melanagromyza vignalis* Spencer (Dipt.: Agromyzidae) | L | Mine seeds externally & internally |
| *Leguminivora (Cydia) ptychora* Meyrick (Lep.: Tortricidae) | L | Bore shoots & drying seeds |
| *Helicoverpa (Heliothis) armigera* Hübner (Lep.: Noctuidae) | L | Feed on fresh pods & seeds |
| *Hymenia* spp. (Lep.: Pyralidae) | L | Feed on flowers, fresh pods & seeds |
| *Muruca vitrata* Fabricius (Lep.: Pyralidae) | L | Feed on flowers, fresh pods & seeds |
| *Virachola* spp. (Lep.: Lycaenidae) | L | Feed on flowers, fresh pods & seeds |
| Coccinellidae (Coleoptera) | A&L | Aphid predator |
| *Paederus* spp. (Col.: Staphylinidae) | A | Larvae are known to be predatory |
| Reduviidae (Heteroptera) | A | Chrysomelid predator |
| Formicidae (Hymenoptera) | A | Observed aphid predator |
| Hymenopteran wasp | A | Prasitoid reared from pyralid larva |

* A: adult L: larva N: nymph

## Results and Discussion

### Inventory of insects on cowpea in the two ecozones

Insects species recorded on cowpea plants in both the southwest forest and western derived savanna zones during the survey in 1986 and 1987, are presented in Table 1. Each insect species occurred in both ecological zones. Many of these insects damaged either the vegetative (leaves and stems) or reproductive (flowerbuds, flowers, pods and seeds) parts of the plants. Their damage probably caused seed yield loss in both ecozones. Many of them have been recorded and reported to be the major cause of cowpea seed yield loss in other countries such as Nigeria (3,4,11); Ghana (12); Uganda (7); Tanzania (5); and Kenya (6).
Insect natural enemies observed in both ecozones during the survey are reported also in Table 1. It is probable that these natural enemies are effecting some degree of natural control of their respective hosts in the survey zones.

### Yield loss (kg/ha) over all cowpea cultivars under eight different spray schedules

The average seed yield loss (kg/ha) from five cowpea cultivars in each main plot of eight different spray schedules at Foumbot in 1988, 1989 and 1990, are presented in Table 2. Each year, the average yield loss from unsprayed plants and from plants sprayed once only during the reproductive stages was higher than that from plants sprayed either fortnightly, three times or two times. The high yield loss recorded in this study for unsprayed and for even sprayed plants in 1988 and 1990 (Table 2), indicated the important contribution which seed insect pests make to the overall seed loss in cowpea in the field in Foumbot. This level of loss is probably in the same range in other cowpea production centres in the southwest and western derived savanna zones, because the same spectrum of seed pests observed in Foumbot was observed also in other cowpea production centres in the two ecological zones. In this study, spray schedules 4, 5 and 6 in which the plants received only two insecticide applications, reduced yield losses at the same level as fortnightly insecticide applications. The low yield losses under spray schedules 4, 5 and 6 indicated that two insecticide applications, applied to the cowpea crops at the particular stage of the reproductive phases of the crops, probably enhanced a good control of flower, pod and seed insect pests.

The quantity of deltamethrin used on the cowpea crop under these spray schedules (4, 5 and 6) was quite less than that used when the crops were sprayed fortnightly. These spray schedules reduced excessive use of deltamethrin and possibly reduced environmental pollution. This study has therefore highlighted the importance of the timing of insecticide application on cowpea in the Foumbot area.

### Contribution to seed yield loss by different seed insect pests

In the Foumbot area during the cowpea cropping seasons of 1988, 1989 and 1990 and the mean percentage loss in cowpea yields caused by key insect pests,

**Table 2**
**Mean overall yield loss (kg/ha) from all 5 cowpea cultivars under each of 8 different spray schedules at Foumbot during 1988, 1989 and 1990 cropping seasons.**

| | | Cropping year and yield loss (kg/ha) | | |
|---|---|---|---|---|
| Spray schedules | | 1988 | 1989 | 1990 |
| Sps. 1: | no spraying | 362.51a | 90.73a | 184.08a |
| Sps. 2: | spraying forthnightly (5-6 sprays) | 130.75b | 15.42c | 91.72d |
| Sps. 3: | sprays at reproductive stage | 160.11b | 21.86c | 108.86cd |
| Sps. 4: | 2 sprays at reproductive stage | 191.19b | 43.19b | 133.88abcd |
| Sps. 5: | 2 sprays at reproductive stage | 123.60b | 23.42c | 129.78bcd |
| Sps. 6: | 2 sprays at reproductive stage | 184.71b | 22.41c | 119.79bcd |
| Sps. 7: | 1 spray at reproductive stage | 209.73b | 46.23b | 158.65abc |
| Sps. 8: | 1 spray at reproductive stage | 371.12a | 48.30b | 170.90ab |

For each year, each tabulated yield figure is a mean from 5 cowpea cultivars. For each year, means followed by the same letters in the same column do not differ significantly (P=0.05: DMRT).

are presented in Table 3. *Melanagromyza vignalis, Maruca vitrata,* heteropteran bugs (which include *Anoplocnemis curvipes, Clavigralla horrida, Aspavia armigera* and *Riptortus dentipes), Leguminivora (Cydia) ptychora* and *Aphis craccivora,* contributed the highest percentage loss in seed yields of all five cowpea cultivars used in this study. Damage by *Apion disjunctum* tended to increase each year because while no seed damage by this insect was recorded in 1988, it started in 1989 and continued in 1990. This indicate that the importance of *Apion disjunctum* might increase in future.

The results in Table 3 show also that *M. vignalis* and heteropteran bugs caused high loss in seed yields in both sprayed and unsprayed plants. This shows that deltamethrin used fortnightly at 12.5 g a.i./ha from 21 d.a.p. to 10 days before harvest, did not effectively control these pests. It is probable that deltamethrin failed to effectively control *M. vignalis* because of its feeding habit. Its larvae feed within seeds inside cowpea pods and are thereby protected against deltamethrin which is a contact insecticide. The larvae might therefore be better controlled in future screening insecticides that would be more effective for their control.

### Healthy seed yields under different spray schedules

Table 4 shows the average seed yield for each year from plants of all five cowpea cultivars under different spray schedules. Each year, yields from sprayed plants were significantly higher than those from unsprayed plants. Except in 1989, yields from plants under spray schedule 8 (one spray at podding) were inferior to those from other sprayed plants. The results indicate that cowpea seed yields in Foumbot area could be increased by use of only two post-flowering insecticide applications. This is because the yields from two post-flowering insecticide sprays are comparable with those obtained from

**Table 3**
**Contribution to % loss in seed yields by each of 8 different seed insect pests for unsprayed ($B_1$) and sprayed ($B_2$) cowpea plants at Foumbot in 1988, 1989 and 1990.**

| Cropping year & cowpea cv. | Unsprayed and sprayed plants | Species of insects and % contribution to seed yield loss | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | *Maruca* | *Legumi nivora* | *Helico-verpa* | *Aphis* | *Apion* | *M. vignalis* | *Heteroptera* bugs | *Bruchids* |
| **1988** Foumbot local | $B_1$ | 33.74 | 9.12 | 3.04 | 0.54 | 0.00 | 12.88 | 35.31 | 5.37 |
| | $B_2$ | 22.52 | 5.03 | 0.54 | 0.00 | 0.00 | 30.84 | 37.91 | 3.18 |
| Badun local | $B_1$ | 14.77 | 8.18 | 1.25 | 0.00 | 0.00 | 43.96 | 30.57 | 0.07 |
| | $B_2$ | 4.52 | 4.90 | 0.25 | 0.00 | 0.00 | 71.27 | 19.04 | 0.00 |
| Melong local | $B_1$ | 14.31 | 14.85 | 1.12 | 0.00 | 0.00 | 36.02 | 31.94 | 1.76 |
| | $B_2$ | 4.16 | 4.20 | 0.13 | 0.00 | 0.00 | 72.08 | 18.33 | 0.39 |
| Befang local | $B_1$ | 27.89 | 4.50 | 1.76 | 10.13 | 0.00 | 39.59 | 22.65 | 1.46 |
| | $B_2$ | 5.48 | 0.46 | 0.00 | 1.81 | 0.00 | 68.55 | 13.92 | 1.07 |
| MA 2/1 | $B_1$ | 12.47 | 1.43 | 1.68 | 56.80 | 0.00 | 8.78 | 16.30 | 6.55 |
| | $B_2$ | 22.53 | 0.00 | 0.59 | 10.29 | 0.00 | 27.06 | 28.76 | 1.46 |
| MEANS | $B_1$ | 20.64 | 7.62 | 1.77 | 13.83 | 0.00 | 28.25 | 27.35 | 3.04 |
| | $B_2$ | 11.84 | 2.92 | 0.30 | 2.42 | 0.00 | 54.09 | 23.59 | 1.22 |
| **1989** Foumbot local | $B_1$ | 40.87 | 5.86 | 8.49 | 0.46 | 1.72 | 12.70 | 28.07 | 1.82 |
| | $B_2$ | 19.70 | 5.36 | 1.56 | 0.00 | 0.68 | 16.52 | 47.68 | 0.00 |
| Badun local | $B_1$ | 43.56 | 8.40 | 1.32 | 0.00 | 0.45 | 17.18 | 28.58 | 0.96 |
| | $B_2$ | 29.86 | 0.00 | 0.00 | 0.00 | 0.00 | 28.76 | 40.42 | 0.52 |
| Melong local | $B_1$ | 43.65 | 16.24 | 2.56 | 4.69 | 0.14 | 10.03 | 25.16 | 2.30 |
| | $B_2$ | 14.42 | 0.00 | 0.00 | 0.00 | 1.56 | 36.64 | 40.90 | 0.81 |
| Befang local | $B_1$ | 35.99 | 1.99 | 0.84 | 0.00 | 1.77 | 35.12 | 23.09 | 1.20 |
| | $B_2$ | 2.59 | 0.00 | 0.00 | 0.00 | 2.00 | 47.88 | 22.54 | 0.00 |
| MA 2/1 | $B_1$ | 36.38 | 10.24 | 0.44 | 11.04 | 1.15 | 17.88 | 31.51 | 3.13 |
| | $B_2$ | 3.52 | 15.00 | 3.13 | 2.41 | 0.00 | 36.97 | 27.22 | 0.00 |
| MEANS | $B_1$ | 40.09 | 8.55 | 2.73 | 3.24 | 1.05 | 18.58 | 27.28 | 1.88 |
| | $B_2$ | 14.02 | 4.07 | 0.94 | 0.48 | 0.85 | 33.35 | 35.75 | 0.29 |
| **1990** Foumbot local | $B_1$ | 68.00 | 5.04 | 3.14 | 0.58 | 3.70 | 7.00 | 11.56 | 2.54 |
| | $B_2$ | 73.34 | 2.78 | 0.70 | 0.28 | 1.88 | 3.38 | 14.76 | 1.30 |
| Badun local | $B_1$ | 69.98 | 5.40 | 0.44 | 0.40 | 0.84 | 11.42 | 10.92 | 0.64 |
| | $B_2$ | 55.76 | 3.36 | 0.08 | 0.00 | 0.08 | 16.32 | 23.16 | 0.20 |
| Melong local | $B_1$ | 50.76 | 9.00 | 1.20 | 8.04 | 3.52 | 8.42 | 18.66 | 1.28 |
| | $B_2$ | 61.86 | 3.72 | 0.12 | 0.62 | 1.62 | 11.22 | 18.96 | 0.40 |
| Befang local | $B_1$ | 53.30 | 8.92 | 1.38 | 1.64 | 4.28 | 14.90 | 14.72 | 1.24 |
| | $B_2$ | 51.68 | 3.98 | 0.24 | 0.60 | 2.52 | 14.70 | 25.08 | 0.78 |
| MA 2/1 | $B_1$ | 58.78 | 5.90 | 2.90 | 4.66 | 6.52 | 8.54 | 13.82 | 2.50 |
| | $B_2$ | 55.92 | 1.68 | 0.68 | 2.72 | 0.70 | 8.00 | 25.84 | 0.84 |
| MEANS | $B_1$ | 60.16 | 6.85 | 1.81 | 3.06 | 3.77 | 10.06 | 13.94 | 1.64 |
| | $B_2$ | 59.71 | 3.10 | 0.36 | 0.84 | 1.36 | 10.72 | 21.56 | 0.71 |

For each year, each tabulated figure is a mean from 5 blocks.

plants sprayed fortnightly. This reduces the number of insecticide sprays from 5 to 6, to only two during the cycle of the crop. These results are similar to those reported by Raheja and Apeji (10) and Amatobi (1,2) who showed in Northern Nigeria, that seed yield in cowpea could be increased by use of one to three post-flowering insecticide spray applications.

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**Table 4**
**Seed yield response of five cowpea cultivars to treatments of eight different deltamethrin spray schedules at Foumbot during the 1988, 1989 and 1990 cowpea cropping season.**

| Spray schedules | | Cropping year and yield loss (kg/ha) | | |
|---|---|---|---|---|
| | | 1988 | 1989 | 1990 |
| Sps. 1: | no spraying | 974.59d | 1024.86b | 816.93c |
| Sps. 2: | spraying forthnightly (5-6 sprays) | 2112.21a | 1121.92ab | 1547.69a |
| Sps. 3: | 3 sprays at reproductive stage | 1692.21b | 1266.02a | 1476.83ab |
| Sps. 4: | 2 sprays at reproductive stage | 1495.71b | 1161.48ab | 1277.08b |
| Sps. 5: | 2 sprays at reproductive stage | 1603.51b | 1201.34ab | 1351.89ab |
| Sps. 6: | 2 sprays at reproductive stage | 1572.36b | 1236.09a | 1375.85ab |
| Sps. 7: | 1 spray at reproductive stage | 1571.88b | 1300.92a | 1316.12b |
| Sps. 8: | 1 spray at reproductive stage | 1181.34c | 1257.34a | 904.29c |

For each year, each tabulated yield figure is a mean from 5 cowpea cultivars. For each year, means followed by the same letters in the same column do not differ significantly (P=0.05: DMRT).

## Literature


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I.A.Parh, Cameroonian, Senior Lecturer and Researcher in the Food Agricultural Entomology, University of Dschang, P.O.Box 308, Dschang - Cameroon.