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Full Length Research Paper

Effects of insecticide spray application on insect pest infestation and yield of cowpea [*Vigna unguiculata* (L.) Walp.] in the Transkei, South Africa

W. D. Dzemo[1], A. S. Niba[1]* and J. A. N. Asiwe[2]

[1]Department of Zoology, Walter Sisulu University, P/B X1 NMD Mthatha 5117, South Africa.
[2]Agricultural Research Council (ARC), Small Grain Institute, Private Bag X29, Bethlehem 9700, South Africa.

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Field studies were conducted during the 2008 - 2009 cropping season to determine the minimal insecticide application which can reduce cowpea yield losses on the field due to insect pest infestations in the Transkei region of South Africa. Treatments consisted of five cowpea varieties and four regimes of insecticide spray which were laid out with a split-plot experimental design with four replications. Observations were taken on the incidence of major insect pests, cowpea pod and seed damage by insects as well as growth and yield parameters of the cowpea varieties. Results showed that spray regimes had significant effects on insect population counts, pod and seed damage and consequently on cowpea yield parameters. Application of insecticide once each at flower budding and early podding significantly reduced pod borers and pod-sucking bugs infestations by 44 and 56%, respectively, compared to the untreated control. Application of insecticide, once at flower budding, early podding and pod filling significantly reduced pod and seed damage, resulting in substantial increase in number of pods, pod weight and seed weight per plant, and also number of seeds per pod of cowpea compared to the untreated control. This study provides information on the incidence of major insect pests of cowpea as well as the minimum insecticide control intervention necessary for effectively reducing cowpea yield losses on the field. Two insecticide spray regimes (once at flowering and podding) significantly reduced insect population and damage of cowpea.

Key words: Cowpea, insecticide spray, insect pests, yield.

INTRODUCTION

Cowpea [*Vigna unguiculata* (L.) Walp] is a subsistence crop and major source of cheap vegetable protein for rural farmers of the Transkei region of South Africa (Voster et al., 2007). It is mostly grown as an intercrop with sorghum, maize and millet (Asiwe, 2007; Voster et al., 2007). Cowpea is usually preferred by farmers because of its role in maintaining soil fertility through nitrogen-fixing (Blade et al., 1997; Asiwe et al., 2009a) and production of nutritious fodder for livestock. Under sole cropping, the potential grain yield is high (1.5 - 3.0 t ha^{-1}), especially, when insecticide is applied. However, the actual farm yields obtained by farmers in South Africa are much lower averaging less than 500 kg ha^{-1} (Asiwe 2007, 2009b). Insect pests are considered to be largely responsible for this as their attack can result in up to 90 - 100% yield reduction (Jackai and Daoust, 1986). Major insect pests of cowpea in South Africa, include aphids (*Aphis craccivora*), pod borers (*Maruca vitrata* and *Helicoverpa armigera)* and the pod-sucking bug (PSB) complex of which *Clavigralla* sp., *Anoplocnemis curvipes* and *Mirperus jaculus* are the most damaging (Jackai and Adalla, 1997). Generally, peasant farmers growing cowpea in the Transkei region leave cowpea protection to chance or nature. The low yield obtained from such farmers' fields suggests that natural control by itself cannot afford enough protection as to enhance profitable commercial production (Jackai and Singh, 1983). The use of varieties that are resistant to attack by insect pests is one of the most promising alternative control measures since it is

*Corresponding author. E-mail: Aniba@wsu.ac.za. Tel: +27 47 5022894. Fax: +27 47 5022725.

Table 1. Characteristic of varieties used in the study.

Variety	Source	Maturity	Growth habit	Photosensitivity	Seed coat colour
Glenda	ARC	Medium	Semi erect	PS	Red
Bechuana White	ARC	Late	Runner	PS	Cream
Ife Brown	IITA	Medium	Semi erect	PS	Brown
IT03K-369-3	IITA	Early	Semi erect	NPS	Red
IT04K-221-1	IITA	Early	Semi erect	NPS	White

NPS = Non-photosensitive; PS = photosensitive; IITA = International Institute of Tropical Agriculture; ARC = Agricultural Research Council.

economically and environmentally safe (Tamo et al., 1997). However, despite concerted efforts by many institutions over the last two decades to develop varieties with resistance to the cowpea insect pest complex, resistant varieties are still unavailable to farmers. Chemical control using synthetic insecticides therefore remains the most popular control tactic especially when these pests have exceeded the economic injury level (Jackai et al., 2001). However, excessive use of chemical insecticides is hazardous to humans and the environment, and often leads to the elimination of ecologically beneficial insects as well as the development of resistance by insect pests (Immaraju et al., 1992; Ekesi, 1999). Furthermore, chemical insecticides are not affordable to a majority of peasant farmers (Bottenberg, 1995). To enhance the efficacy of insecticides and reduce their indiscriminate use, their application should be carefully timed and managed to coincide with stages in crop phenology where pest pressure is high. Several studies in tropical Africa have suggested that spraying twice (once at flowering and podding) is sufficient to control insect pests and increase cowpea grain yield (Alghali, 1992; Amatobi, 1995; Kyamanywa, 1996; Parh, 1993; Ajeigbe and Singh, 2006). In Transkei, no insect pest control studies or spray schedules as in the tropical agro-ecosystems has been conducted, especially for the arid grassland agro-ecological zone of the Transkei where subsistence and rural farmers are being encouraged and empowered to cultivate indigenous food crops and vegetables that are rich in nutritive plant protein and other macro-nutrients such as cowpea. Baseline data are important to make empirical decision for cowpea pest management in the Transkei. This study therefore aims to determine the minimal frequency of insecticide application that can substantially reduce cowpea insect pest infestations and increase yield. Such spray regime will not only increase their productivity and family income but also increase their employment potentials within the community.

MATERIALS AND METHODS

Study area

On-farm trials were conducted during the 2008 - 2009 cropping season (November 2008 to April, 2009), at the Walter Sisulu University Research Farm, NMD Campus, (31°36'S; 28°46'E), the Efata School for the Blind farming site in Mthatha (31°33'S; 28°42'E) and the Tsolo Agricultural and Rural Development Institute, Tsolo (31°17'S; 28°45'E). All locations are within the grassland agro-ecological zone of the Transkei region in South Africa. The Transkei has marginal topsoil with the depth of topsoil being 501-701 mm, phosphorous status is 10.1-15.0 mg/ kg, proportion of organic carbon in the soil was 10.0-20.0% and pH was 6.5-7.5. Average rainfall during the study period (November 2008-April 2009) ranged from 701 - 800 mm.

Cowpea varieties and insecticide treatments

The treatments included five cowpea varieties whose agronomic characteristics are outlined in Table 1 and four insecticide treatments. Cowpea varieties used for the study included: Glenda and Bechuana-White. Both local varieties were obtained from the Agricultural Research Council (ARC)-Grain Crops Institute, Potchefstroom, South Africa; two improved varieties, IT03K-369-3 and IT04K-221-1 obtained from the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria; and Ife-Brown, a popular variety grown by local farmers in Western Nigeria. The following four insecticide spray treatments were used:

i) No insecticide spray (untreated control);
ii) Two sprays: one at flower budding and the second at early podding, using a standard insecticide formulation of deltamethrin + dimethoate at the dose of 30 + 250 g a.i/ l. Dimethoate is a systemic and stomach-poisoning insecticide. It is very effective in the control of pod-sucking bugs and less effective on the pod borers (Jackai, 1983).
iii) Three sprays: one at flower budding, a second at early podding and third at pod filling, using a standard insecticide formulation of deltamethrin + dimethoate at the dose of 30 + 250 g a.i/ l;
iv) Five sprays: two sprays at seedling (7-10 days time interval); one spray each at flower budding, early and late podding, using Lamda cyhalothrin (Karate), the locally recommended insecticide for cowpea pest (treated control). Karate is contact and stomach-poisoning insecticide.

It is important to note that the essence of these spray regimes was to regulate the population of the insects as a function of their effectiveness and efficacy. In the case of the treated control, we simulated a perfect protection of the crop where no damage by insect interference was possible.

Experimental design

In each location, the experimental field was laid out in a split plot design where varieties were in sub-plots and spray regimes in the main plots. This was to reduce the effect of wind drift. For each spray regime, sub-plots were arranged in randomized complete block designs with four replications. Sub-plot sizes consisted of four ridges spaced at 0.50 m apart and 3.00 m long separated by 1.50 m weedy alley ways to reduce insecticide drift during spraying.

Crop establishment

Three seeds of each cultivar were sown at intra-row spacing of 0.30 m each for both the semi-erect and runner cultivars. The plants were later thinned to two plants per stand two weeks after emergence. The crops were sown during the first week of November, 2009. Irrigation of the experimental plots was done before sowing and continued when there was minimal or no rainfall. Weeds were controlled manually at 2, 6 and 10 weeks after sowing (WAS). For each spray regime, the insecticides were formulated as described above and applied with a knapsack sprayer fitted with a cone nozzle.

Data collection

Data were collected on number of days to 50% flowering and pod maturity of the cowpea varieties. Two inner rows were selected for sampling insects in the sub-plots. Where infestations by lepidopteran pod borers were observed, their population was estimated by randomly picking 20 racemes/flowers per sub-plot. The flowers were opened and examined for the presence of exit/ entry holes, lepidopteran pod borer larvae and/or presence of frass. The infestation was assessed once weekly in the morning (between 8.00 a. m. and 12.00 noon) starting at the onset of flowering. Counts were expressed as number of lepidopteran pod borers per 20 flowers. Pod-sucking bugs (PSBs), when observed were counted in the two middle rows of each sub-plot. Insects were counted weekly, usually between 8 a. m. and 12 noon. The number of nymphs and adults of PSBs observed within the sampling areas (20 plants in each of the two middle rows marked at 3 m row length) were counted separately but pooled together prior to data analysis since their feeding damage were not distinguishable on pods at the time of data collection. Counts were expressed as number of PSBs per 20 plants within each plot.

Pod damage (shrivelling, twisting, stunting, constriction and presence of entry/exit holes of lepidopteran pod borer on pods) was assessed by examining 20 pods randomly selected from ten plants per sampling area. Damage was then expressed as percentage of the total number of pods assessed per plot. At maturity, all pods from five plants were selected randomly from the middle two rows to determine various yield and damage parameters. The data collected included number of pods per plant, pod weight per plant, number of seeds per pod and seed weight per plant. Pod and seed weight were determined using a sensitive Top Pan Balance, (Model: FEL-200S, RS-232). In order to assess seed damage, seeds were observed for feeding symptoms such as wrinkling of the seed coat, browning or shrivelling of the seeds and presence of suction punctures on the seeds. Seed damage indices (Sdi), were determined by sorting the seed lot from each plot into 3 categories as described by Gilman et al. (1982). Category A consisted of seeds with no feeding damage; category B, seeds with obvious feeding punctures but with mild wrinkles and category C, seeds with holes and/or seeds that are severely wrinkled and shrunken to small sizes. The proportion of each category from each treatment subplot was counted, weighed and expressed as percentage of the total weight of seeds assessed. To compute the Sdi, a slight modification of the method used by Gilman et al. (1982) was followed (using weights instead of counts) as illustrated below:

Sdi = 0.5 (% seed weight in category B) + (% seed weight in category C).

Percentage seed weight in each category = 100 (seed weight in that category ÷ total seed weight per plot).

Data analysis

Analysis of variance (ANOVA) was performed using statistical package for the social sciences (SPSS) (version 17). Replication or block was treated as random effect and variety was treated as fixed effect in determining expected mean squares and appropriate F-tests in the analysis of variance. Mean comparisons were determined using the least significant difference (LSD) test at the 5% probability level.

RESULTS

Effect of insecticide spray regimes on cowpea insect pests

There were no significant interactions between location and cultivar in the population of lepidopteran pod borers and pod-sucking bugs (PSBs) for each spray regime. Data were therefore pooled together across locations prior to analysis. There was a higher level of insect infestation in plots with no application of insecticide, while the plots that received insecticide sprays had a lower level of infestation. Application of insecticides once at flower budding and early podding reduced pod borer populations by 44% and PSBs by 56% and significantly ($P < 0.05$) reduced pod borer and PSB population counts compared with the untreated control (Table 2). The same trend was observed with application of insecticides once at flower budding, early and late podding stages, but with better control of insect pests; with 59% reduction of pod borers and 69% of PSBs. There were higher populations of PSBs than that of pod borers at all spray regimes. There were no significant differences among cultivars for pod borer and PSB populations. Interaction effects between cultivars and spray regimes were also not significant ($P > 0.05$). However, the number of insects sampled on improved cowpea cultivars was relatively higher than for local cultivars used in the study.

Effects of insecticide spray regimes on pod and seed damage

There were no significant interactions between experimental sites and cultivar for pod damage and seed damage for each spray regime. Data were therefore pooled together across locations prior to analysis. Generally, there was a higher level of pod and seed damage with no application of insecticide (Table 3). Application of insecticides once at flower budding and at early podding did not result in significant reduction in seed damage compared with the untreated control. However, this insecticide spray regime resulted in significant ($P < 0.05$) reduction in pod damage compared with the untreated control. The 3 insecticide sprays regime was as good as the 5 insecticide

Table 2. Lepidopteran pod borer and pod-sucking bug population counts on cowpea varieties under different spray regimes.

Variety/ treatment	No spray	2 Sprays	3 Sprays	5 Sprays	Mean
Lepidopteran pod borers/ 20 flowers					
Glenda	3.56 ± 0.15	2.60 ± 0.33	1.53 ± 0.17	0.57 ± 0.81	2.07 ± 0.65a
Bechuana white	4.17 ± 0.32	2.27 ± 0.60	1.47 ± 0.53	0.53 ± 0.75	2.11 ± 0.77a
Ife brown	4.40 ± 0.28	3.60 ± 0.75	2.37 ± 0.21	1.13 ± 0.31	2.63 ± 0.72a
IT03K-369-3	5.90 ± 0.10	2.83 ± 0.67	2.57 ± 0.17	1.27 ± 0.76	3.14 ± 0.98a
IT04K-221-1	6.47 ± 0.73	2.33 ± 0.82	1.93 ± 0.86	1.07 ± 0.85	3.20 ± 1.2a
Mean	4.90 ± 0.59a	2.73 ± 0.24b	1.97 ± 0.22b	0.91 ± 0.15c	
Pod-sucking bugs/ 20 plants					
Glenda	5.53 ± 0.18	1.8 ± 0.70	1.96 ± 0.33	1.13 ± 0.56	2.61 ± 0.99a
Bechuana white	6.03 ± 0.82	3.27 ± 1.2	2.43 ± 0.76	1.90 ± 0.22	3.41 ± 0.92a
Ife brown	7.67 ± 0.66	3.97 ± 1.5	2.03 ± 0.68	2.37 ± 0.18	4.01 ± 1.29a
IT03K-369-3	10.37 ± 0.16	4.83 ± 0.32	3.27 ± 0.84	2.73 ± 0.87	5.30 ± 1.75a
IT04K-221-1	13.23 ± 0.90	4.97 ± 0.28	3.60 ± 0.27	3.53 ± 0.82	6.33 ± 2.32a
Mean	8.57 ± 1.40a	3.77 ± 0.58b	2.66 ± 0.33b	2.33 ± 0.40b	

No spray = Untreated control; 2 sprays = one at flower budding and the second at early podding, using deltamethrin + dimethoate at the dose of 30 + 250 g a.i/ l; 3 Sprays = one at flower budding, second at early podding and third at pod filling, using a deltamethrin + dimethoate at the dose of 30 + 250 g a.i/ l; 5 sprays = two sprays at seedling; one spray each at flower budding, early podding and pod filling, using Lamda cyhalothrin (Karate).
Means (± SE) with the same letter are not significantly different (P < 0.05).

Table 3. Effects of insecticide spray regimes on pod damage (%) and seed damage indices of cowpea varieties.

Variety / treatment	No spray	2 Sprays	3 Sprays	5 Sprays	Mean
Pod damage (%)					
Glenda	65.0 ± 2.33	48.3 ± 2.17	30 ± 1.86	30.0 ± 2.3	43.33 ± 8.41a
Bechuana White	61.67 ± 2.75	46.67 ± 2.53	33.33 ± 1.22	35.0 ± 2.0	44.17 ± 6.55a
Ife brown	60.0 ± 3.67	48.33 ± 2.21	40.0 ± 1.52	33.33 ± 2.9	45.42 ± 5.75a
IT03K-369-3	78.33 ± 3.82	65.0 ± 1.17	38.33 ± 1.32	43.33 ± 1.6	56.25 ± 9.36a
IT04K-221-1	80 ± 3.81	60.0 ± 1.86	36.33 ± 1.9	41.67 ± 1.2	54.50 ± 9.90a
Mean	69 ± 4.24a	53.66 ± 3.71b	35.59 ± 1.79c	36.67 ± 2.53c	
Seed damage index					
Glenda	27.86 ± 2.27	19.28 ± 1.16	11.24 ± 0.7	8.05 ± 1.21	16.61 ± 4.43a
Bechuana White	28.42 ± 2.53	27.11 ± 1.32	18.45 ± 0.9	17.09 ± 1.42	21.27 ± 2.91a
Ife brown	33.31 ± 2.31	33.34 ± 1.28	21.80 ± 1.8	21.93 ± 1.0	27.60 ± 3.31a
IT03K-369-3	40.93 ± 1.17	32.56 ± 1.13	18.39 ± 1.9	19.40 ± 1.32	27.82 ± 5.43a
IT04K-221-1	41.21 ± 1.86	34.19 ± 1.33	18.45 ± 0.8	20.39 ± 1.12	28.56 ± 5.48a
Mean	34.35 ± 2.91a	28.10 ± 2.79a	17.67 ± 1.73b	17.37 ± 2.46b	

No spray = Untreated control; 2 sprays = one at flower budding and the second at early podding, using deltamethrin + dimethoate at the dose of 30 + 250 g a.i/ l; 3 Sprays = one at flower budding, second at early podding and third at pod filling, using a deltamethrin + dimethoate at the dose of 30 + 250 g a.i/ l; 5 sprays = two sprays at seedling; one spray each at flower budding, early podding and pod filling, using Lamda cyhalothrin (Karate).
Means (± SE) with the same letter are not significantly different (P < 0.05).

spray regime in reducing pod and seed damage. The application of insecticides once at flower budding and at early podding, reduced pod damage by 22% and seed damage by 18%. A better percentage reduction in pod (48%) and seed damage (48%) was observed with application of insecticides once at flower budding, early and late podding. The data showed positive relationships between insect pest infestation levels and percentage pod damage. Pest infestation levels also positively correlated with seed damage. There were no significant

Table 4. Effects of insecticide spray regimes on number of pods and pod weight per plant of cowpea varieties.

Variety / treatment	No Spray	2 Sprays	3 Sprays	5 Sprays	Mean
Number of pods per plant					
Glenda	4.07 ± 0.32	6.3 ± 0.92	10.33 ± 0.97	12.27 ± 1.12	8.24 ± 1.87a
Bechuana White	4.0 ± 0.36	4.3 ± 0.73	9.73 ± 1.57	11.93 ± 1.32	7.49 ± 1.98a
Ife brown	5.13 ± 0.76	6.87 ± 0.74	12.4 ± 0.53	11.27 ± 1.28	8.92 ± 1.74a
IT03K-369-3	8.07 ± 0.66	9.87 ± 0.86	17.67 ± 0.78	17 ± 1.10	13.15 ± 2.45a
IT04K-221-1	7.47 ± 0.48	9.33 ± 0.83	17.33 ± 0.92	16.3 ± 1.0	12.61 ± 2.47a
Mean	5.75 ± 0.85b	7.33 ± 1.02b	13.49 ± 1.69a	13.75 ± 1.19a	
Pod weight (g) per plant					
Glenda	12.95 ± 1.72	13.78 ± 1.21	19.85 ± 1.81	19.21 ± 0.75	16.45 ± 1.79a
Bechuana White	7.85 ± 1.67	8.38 ± 1.32	15.35 ± 1.67	18.27 ± 1.21	12.46 ± 2.58a
Ife brown	10.63 ± 0.82	13.55 ± 0.89	22.69 ± 1.78	24.2 ± 1.63	17.77 ± 3.35a
IT03K-369-3	17.31 ± 1.17	19.64 ± 0.86	25.66 ± 2.72	24.33 ± 1.12	21.74 ± 1.96a
IT04K-221-1	15.66 ± 1.53	17.06 ± 1.81	24.79 ± 2.81	32.57 ± 3.67	22.52 ± 3.91a
Mean	12.88 ± 1.70b	14.48 ± 1.90b	21.67 ± 1.87a	23.72 ± 2.54a	

No spray = Untreated control; 2 sprays = one at flower budding and the second at early podding, using deltamethrin + dimethoate at the dose of 30 + 250 g a.i/ l; 3 Sprays = one at flower budding, second at early podding and third at pod filling, using a deltamethrin + dimethoate at the dose of 30 + 250 g a.i/ l; 5 sprays = two sprays at seedling; one spray each at flower budding, early podding and pod filling, using Lamda cyhalothrin (Karate).
Means (± SE) with the same letter are not significantly different ($P < 0.05$).

differences among varieties for pod and seed damage, and interaction effects between cultivars and spray regimes were also not significant ($P > 0.05$).

Effect of insecticide spray regimes on yield components of cowpea

The effect of insecticide spray regimes on the yield parameters of cowpea are indicated in Tables 4 and 5. There were significant ($P < 0.05$) differences in the number of pods per plant, pod weight per plant, number of seeds per pod and seed weight per plant between the untreated control and the application of insecticides once at flower budding, early and late podding. However, there were no significant differences between the 3 insecticide spray regime and the 5 insecticide spray regime for all the yield parameters evaluated. There were significant ($P < 0.05$) differences among cultivars for number of seeds per pod and seed weight per plant (Table 5). The local variety, Bechuana-White recorded significantly lower number of seeds per pod and seed weight per plant, compared to the improved varieties.

DISCUSSION

Cowpea is known to shed up to 80% of its flowers due to natural causes during development, and this could negatively affect pod formation (Ojehomon, 1968). Pod set could also be affected by other factors such as growing conditions, soil fertility, moisture content and pod damage. Pod and seed damage as observed in our study, is clearly related to the effects of the insecticide sprays on insect infestation. Although the damage inflicted on the cowpea plant is known to stimulate compensatory flowering/ pod production, such tendency would be more pronounced during early flowering than mid-podding stage when such compensatory mechanisms would have ceased (Jackai et al., 1989). In this study, with the aid of the insecticide, the compensation or reflush will be quicker depending on whether the spray regime was timely in targeting the insect population build-up or not. In nature, peak populations of pod pests do not occur at early flowering unless the crop is planted late. Therefore, high levels of pod pests at podding stage could lead to total loss of the crop, especially where there is little or no rain to trigger new flushes or re-growth.

Cowpea yield parameters from plots that received insecticides during the seedling, flower budding and early podding stages of cowpea, did not differ significantly from yields obtained from plots sprayed once at flower budding and twice at podding suggesting that damage inflicted to cowpea by insect pests at seedling stage did not reduce yield. This possibly implies that cowpea seedling pests are not a serious threat to cowpea production. This result, confirms the findings of Wien and Tayo (1978) who demonstrated that 50% defoliation of cowpea leaves in the vegetative phase did not significantly reduce grain yield. Results from this study therefore, clearly indicate that insect pest infestations at flowering and podding stages are a significant limiting factor to increased and sustainable cowpea grain production in the Transkei. This corroborates the findings of Asiwe (2009c), Karungi et al.

Table 5. Effects of insecticide spray regimes on seed per pods and seed weight per plant of cowpea varieties.

Variety / treatment	No Spray	2 Spray	3 Sprays	5 Spray	Mean
Number of seeds per pod					
Glenda	6.6 ± 0.73	8.95 ± 0.86	9.4 ± 0.82	10.3 ± 0.87	8.81 ± 0.79a
Bechuana White	4.45 ± 0.6	5.65 ± 0.81	8.05 ± 0.76	8.5 ± 0.89	6.66 ± 0.97b
Ife brown	7.4 ± 0.75	7.45 ± 0.75	9.25 ± 0.85	10 ± 0.78	8.53 ± 0.65ab
IT03K-369-3	8.25 ± 0.49	8.76 ± 0.76	10.05 ± 0.87	11.17 ± 0.76	9.56 ± 0.66a
IT04K-221-1	9.15 ± 0.75	9.7 ± 0.85	11.45 ± 0.67	11.6 ± 0.66	10.48 ± 0.62a
Mean	7.17 ± 0.80c	8.1 ± 0.71bc	9.64 ± 0.56ab	10.31 ± 0.54a	
Seed weight (g) per plant					
Glenda	8.25 ± 0.78	10.57 ± 0.97	12.48 ± 0.73	11.74 ± 0.89	10.76 ± 0.92ab
Bechuana White	6.05 ± 1.12	6.43 ± 0.85	10.47 ± 1.5	12.37 ± 1.45	8.83 ± 1.55b
Ife brown	7.86 ± 0.98	11.88 ± 0.99	12.94 ± 1.21	11.25 ± 1.02	10.98 ± 1.11ab
IT03K-369-3	9.65 ± 1.28	14.88 ± 1.26	18.25 ± 1.66	16.95 ± 1.86	14.93 ± 1.89a
IT04K-221-1	10.7 ± 1.28	12.37 ± 1.23	17.12 ± 1.67	15.57 ± 1.26	13.94 ± 1.46a
Mean	8.5 ± 0.79b	11.23 ± 1.38ab	14.25 ± 1.47a	13.58 ± 1.13a	

No spray = Untreated control; 2 sprays = one at flower budding and the second at early podding, using deltamethrin + dimethoate at the dose of 30 + 250 g a.i/ l; 3 Sprays = one at flower budding, second at early podding and third at pod filling, using a deltamethrin + dimethoate at the dose of 30 + 250 g a.i/ l; 5 sprays = two sprays at seedling; one spray each at flower budding, early podding and pod filling, using Lamda cyhalothrin (Karate).
Means (± SE) with the same letter are not significantly different (P < 0.05).

(2000), Kyamanywa (1996) and Amatobi (1995), who have shown that pod borers and pod-sucking bugs are important insect pests of cowpea. Pod borers are important pest of the reproductive structures of cowpea with early feeding leading to flower bud and flower abortions, hence poor pod set (Tamo et al., 1997). Significant reduction in pod pest infestation levels was achieved by applying insecticides once, each at flower budding and early podding. This indicates that the two insecticide spray regime (at flowering and again at podding) could produce as good a cowpea crop as the three and five spray regimes. This is of critical importance from the point of view of lower costs, environmental hazards and the effects of spray frequencies and intensity on non-target organisms. The insecticide spray at flower budding controls early pod borer infestations and ensures optimal flower and pod protection. The second spray protects the pods from damage by pod borer and pod-sucking bugs. Our results corroborate the findings of Parh (1993) and Ajeigbe and Singh (2006), who showed that two insecticide sprays once at the onset of flowering and podding could reduce insect infestations as well as seed damage and increase seed yield in tropical West Africa. Furthermore, results from yield parameters indicated that insecticide spray treatments enhanced cowpea growth performance. This resulted in increased number of pods per plant, pod weight per plant, seeds per pod, seed weight per plant and hence more grain yield.

Results from this study also clearly indicate that insecticide application remains an important strategy for suppressing cowpea insect pests on the field if properly managed to coincide with high infestation levels. With proper timing, the two insecticide sprays regime (once at flowering and podding) tested in this study significantly reduced the damage due to insect pests of cowpea. Combination of this spray regime as a minimum insecticide spray strategy can be used complementarily with other pest control options to significantly improve cowpea grain yields as a source of plant protein in local diets, and a means of generating disposable income for subsistence and emerging farmers in the Transkei area.

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