Australian Journal of Crop Science
2(3):115-120 (2008)
ISSN: 1835-2707

Integrating host plant resistance and chemical control in the management of Cowpea pests

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Abstract

Studies were conducted at Manga in the Sudan Savanna zone of Ghana to evaluate the potential of integrating host plant resistance with chemical control in the management of key insect pests of cowpea, *Vigna unguiculata*. None of the improved varieties tested showed significant and consistent resistance to the key pests and there were no significant interaction effects between varieties and spray regime. The local varieties, *Omondaw* and *Bengsogla* however supported relatively fewer *Megalurothrips sjostedti* and pod sucking bug (PSB) populations and thus suffered significantly lower damage (shriveled pods) and produced better yields under no insecticide protection than the improved varieties. This was particularly evident in 2005 when the pest population was very high. Spraying the crop with Karate during the reproductive phase produced better results than with neem extracts. Nevertheless, applying neem seed extracts twice and four times increased grain yield by 45 – 54 % and 126 – 144 % respectively over the control, confirming their potential in cowpea Integrated Pest Management.

Key words : Cowpea, *Vigna unguiculata*, chemical control, host plant resistance, Neem extracts.

Introduction

Cowpea (*Vigna unguiculata* L Walp) is probably the most important legume in the farming systems of Northern Ghana. It is usually grown in association with cereals crops, notably millet, sorghum and maize. Although potential yields of improved varieties can be as high as 3 tons.ha^{-1}, farmers seldom harvest up to 500 kg.ha^{-1} of grain even when they grow such varieties. Insect pests are considered to be largely responsible for this as their attack can result in up to 90 – 100 % yield reduction (**.** Ezuah 1982, Jackai & Daoust 1986; Singh et al, 1990; Tanzubil 1991**)**. There are about nine important pests of cowpeas worldwide and most locations have 2 – 4 species being key pests (Agyen-Sampong 1978). In Ghana, the most damaging pests are flower bud thrips, *Megalurothrips sjostedti* Tryb. (Thysanoptera : Thripidae), the legume pod borer, *Maruca vitrata* Fab. (Lepidoptera : Pyralidae) and the pod sucking bug (PSB) complex of which *Clavigralla spp.*Stal. (Hemiptera : Coreidae), *Anoplocnemis curvipes* Fab. (Hemiptera : Coreidae), *Riptortus dentipes* Fab. (Hemiptera : Alydidae) and *Aspavia armigera* are the most damaging (Tanzubil 1991**,** 2000; Jackai 1995**).** Attack by these insects is often so severe that farmers obtain no yields, especially when improved cowpea varieties are grown without insecticide protection (Tanzubil 1991**,** 2000). Consequently, this has limited the a doption of

Table 1. Thrips, pod sucking bug populations and yield of three cowpea varieties subjected to different spray regimes (2005)

	Thrips per flower				*Pod sucking bugs per row*				*Grain yield (k.ha $^{-1}$)*			
Spray	**Black eye**	**Brown eye**	**Vallenga**	**Mean**	**Black eye**	**Brown eye**	**Vallenga**	**Mean**	**Black eye**	**Brown eye**	**Vallenga**	**Mean**
Karate 4	1.11	1.11	1.11	**1.11c**	4.89	7.22	5.78	**5.96b**	1422.22	1644.44	1556.00	**1541a**
Karate 2	1.00	0.78	0.78	**0.85c**	5.56	6.00	6.00	**5.85b**	1266.67	1311.11	1266.67	**1281b**
Neem 4	9.33	10.33	9.44	**9.70b**	8.33	9.22	6.78	**8.11ab**	1066.67	911.11	1066.67	**1055c**
Neem 2	7.22	9.11	8.89	**8.59b**	8.33	7.89	7.44	**7.89ab**	711.11	755.55	688.89	**719d**
Control	16.89	17.33	16.22	**16.81a**	9.56	9.78	10.00	**9.67a**	488.89	511.11	400.00	**467e**
Mean	**7.11a**	**6.41a**	**6.04a**		**7.33a**	**7.95a**	**7.20a**		**893.33a**	**1026.66a**	**995.65a**	

otherwise high-yielding varieties by source-poor farmers especially in Northern Ghana. Despite concerted efforts by many workers and institutions over the last two decades to develop varieties with resistance to the cowpea pest complex, truly resistant cultivars are still unavailable to farmers. Chemical control via the use of synthetic insecticides thus remains the most popular control tactic. The chemical control technology is however seldom very effective and efficient among the largely peasant farming communities of Northern Ghana. Poor timing of spray applications, inappropriate sprayer calibration, and the use of sub-optimal doses of toxicants are common constraints to the realisation of effective chemical control of cowpea insect pests on most farms (Tanzubil, 1991). Apart from these, insecticides and their application equipment are generally too expensive for peasant farmers problems to purchase. These have necessitated the development of integrated approaches to managing the cowpea pest complex so as to guarantee increased and sustainable production of this important crop in Ghana. One promising combination would be the use of host plant resistance alongside reduced insecticide application. In many crops, the use of varieties with moderate levels of resistance can cut down drastically on the amount and frequency of insecticides applied to control pests. This may result from increased mortality of juvenile stages or prolongation of the developmental period of the insect due to antibiotic effects of allellochemicals present in the resistant host plant. In the present studies, the reaction of promising cowpea varieties to insects was assessed under different insecticide spray regimes. The objective was to identify materials that best maintain their high yield potential under reduced or no insecticide (botanical and synthetic) protection. Such varieties would probably be very useful to the peasant farmers who lack the resources to effectively manage insect pest populations via chemical control.

Materials and methods

Field trials were conducted between 2005 and 2006 at the Manga Research Station in the Sudan savanna zone of Ghana. In the first experiments, three improved cowpea varieties released by the National Research System (namely *Vallenga*, Black Eye and Brown Eye) were subjected to 5 treatments in 3 different spray regimes. Treatments consisted of lambda cyhalothrin (Karate), the locally recommended insecticide for cowpea pest control, neem extracts and control. Neem extracts were prepared from neem seed powder extracted in aqueous solutions to give 5% concentration following the methods of Dreyer (19 84). This concentration had been established to be optimum for post-flower cowpea pest control in the Sudan savannah zone of Ghana (Tanzubil, 2000). The experiments were laid out in split plots with Spray Regime (SR) as main plot and variety as subplots. Plots consisted of 5 rows, each 5 m long and treatments were replicated three times. Plant spacing was 75cm between rows and 20cm within rows. The spray regimes were 2 sprays Karate, 4 sprays Karate, 2 sprays neem extract, 4 sprays neem extract and control. For 2 spray treatments, applications were done at flowering and at podding, while 4 sprays were affected weekly from flower bud initiation. Thrips populations were estimated from 10 flowers harvested randomly from

Table 2. Thrips, pod sucking bug populations and yield of three cowpea varieties subjected to different spray regimes (2006)

	Thrips per flower				***Pod sucking bugs per row***				***Grain yield (kg.ha^{-1})***			
Spray	**Black eye**	**Brown eye**	**Vallenga**	**Mean**	**Black eye**	**Brown eye**	**Vallenga**	**Mean**	**Black eye**	**Brown eye**	**Vallenga**	**Mean**
Karate 4	4.8	4.0	3.6	**4.13d**	3.8	5.6	5.8	**5.07c**	1282.22	1444.44	1400.00	**1375.55a**
Karate 2	2.4	1.6	1.2	**1.73d**	10.6	6.8	7.2	**8.20c**	987.67	1076.11	1066.67	**1045.48b**
Neem 4	19.6	13.5	12.6	**15.23c**	11.5	9.7	14.8	**12.00b**	933.32	857.65	966.67	**919.21b**
Neem 2	17.6	24.1	19.3	**20.33b**	14.4	16.6	7.4	**12.80b**	479.87	566.68	588.89	**545.15c**
Control	46.9	38.3	36.2	**40.47a**	29.6	21.2	20.0	**23.60a**	298.89	466.67	366.67	**377.41c**
Mean	**18.26a**	**16.30a**	**14.58a**		**13.98a**	**11.98a**	**11.00a**		**7996.3a**	**882.23a**	**877.78a**	

Table 3. Thrips and pod sucking bug populations on five cowpea varieties subjected to different spray regimes (2005)

	Thrips per flower				***Pod sucking bugs per row***			
Variety	**Control**	**2 sprays**	**4 sprays**	**Mean**	**Control**	**2 sprays**	**4 sprays**	**Mean**
Black Eye	23.8	6.4	1.3	**10.50a**	36.4	8.6	9.0	**18.00a**
Brown Eye	19.4	8.6	1.8	**9.93ab**	28.6	12.8	8.4	**16.66ab**
Vallenga	21.3	7.9	2.4	**10.53a**	32.6	11.6	6.4	**16.87ab**
Omondaw	18.2	3.6	2.6	**8.13b**	22.8	12.0	4.8	**13.20c**
Bengsogla	14.6	3.8	1.8	**6.73c**	24.0	10.8	7.8	**14.20bc**
Mean	**19.46a**	**6.06b**	**1.98c**		**28.88a**	**11.16b**	**7.28c**	

rows 2 and 4 of each plot 5 days after each spray. PSB populations were estimated 1 week after the second spray, by walking along the centre row of each plot early in the morning and counting bugs on the plants. At maturity the total number of pods, number of shrivelled pods, pod yield and grain yield were determined from the inner three rows of each plot. In the second set of experiments, there were five varieties and 3 spray regimes of Karate (twice, three times and control) applied as before. The 5 varieties consisted of the 3 used in the first experiments plus two local materials *Omondaw* and *Bengsogla*. The latter two are extra-early maturing and are usually grown with little or no chemical protection. All other procedures were similar to those adopted for the first set of experiments. Data from all experiments were subjected to analysis of variance (ANOVA) with means separated by the least significant difference (LSD) technique.

Results

Effect of selective insecticide protection on pest infestation and yield of three improved varieties

The PSB complex was dominated by *Clavigralla. tomentosicollis*, *R. dentipes*, *A. armigera*, *A. curvipes* and *Miperus jaculus* which have in the past been reported attacking cowpea in the country. In both years, spraying the cowpea crop with Karate or Neem

Table 4. Thrips and pod sucking bug populations on five cowpea varieties subjected to different spray regimes (2006)

	Thrips per flower				***Pod sucking bugs per row***			
Variety	Control	2 sprays	4 sprays	**Mean**	Control	2 sprays	4 sprays	**Mean**
Black Eye	41.67	5.33	1.67	**16.2ab**	28.0	11.33	12.00	**17.1a**
Brown Eye	48.67	8.00	13.67	**23.4a**	17.67	19.33	7.67	**14.9a**
Vallenga	48.33	13.00	7.67	**23.0a**	31.67	5.67	13.00	**16.8a**
Omondaw	28.33	6.67	4.00	**13.0b**	27.33	12.00	14.00	**17.8a**
Bengsogla	22.33	7.67	6.33	**12.1b**	23.33	13.67	8.33	**15.1a**
Mean	**37.87**	**8.1b**	**6.7b**		**25.6a**	**12.4b**	**11.2b**	

*2 and 4 sprays refer to number of applications of Karate

Table 5. Pod sucking bug damage to 5 cowpea varieties subjected to different spray regimes.

	% shriveled pods at harvest 2005				***% shrivelled pods at harvest 2006***			
Variety	**Control**	**2 sprays**	**4 sprays**	**Mean**	**Control**	**2 sprays**	**4 sprays**	**Mean**
Black Eye	34.0	8.0	8.2	**16.73a**	53.4	14.80	7.10	**25.1a**
Brown Eye	38.6	6.8	3.4	**16.27a**	67.5	4.22	5.50	**23.7a**
Vallenga	23.6	1.6	1.6	**14.93a**	30.7	1.42	2.15	**21.4a**
Omondaw	24.0	5.0	2.3	**10.43b**	22.8	4.80	3.11	**10.2b**
Bengsogla	16.4	4.2	1.8	**7.47b**	3.27	6.03	4.43	**6.6b**
Mean	**27.32a**	**5.12b**	**3.46b**		**35.5a**	**6.3b**	**4.5b**	

extracts significantly reduced PSB incidence and damage (% shrivelled pods) as well as the incidence of *M. sjostedti*, resulting in higher grain yields than unprotected plots (Tables 1 and 2). The general trend was for yield to increase with increased frequency of spraying for the same active ingredient. Also plots treated with Karate supported significantly lower pest populations than neem-treated ones and generally produced higher yields, though in 2005, 4 sprays of neem was as good as 2 sprays of Karate. There were however no significant differences among varieties for pest infestation and yield and interaction effects between varieties and spray regime were also not significant ($p = 0.05$).

Effect of three spray regimes on yield of improved and local varieties

Results from the trials confirmed *M. sjostedti* and PSB as key pests of cowpea whose attack can result in severe yield losses. In 2005 for instance, the data showed significant negative relationships between yield and each of thrips, PSB and % shriveled pods with correlation coefficients of - 0.72, - 0.64 and – 0.70 respectively. For the two seasons, *M. sjostedti* and PSB populations and damage differed significantly both among varieties and spray regimes (Tables 3 -5). Spraying the crop twice or four times gave more effective control of pests and thus

Table 6. Pod sucking bug damage and yield of 5 cowpea varieties subjected to different spray regimes

	Grain yield kg.ha^{-1} (2005)				Grain yield kg/ha $^{-1}$ (2006)			
Variety	Control	2 sprays	4 sprays	Mean	Control	2 sprays	4 sprays	Mean
Black Eye	219	1086	1467	**924bc**	102.2	566.6	688.9	**486b**
Brown Eye	305	1667	1768	**1247a**	26.6	1333.3	1377.8	**898a**
Vallenga	267	1333	1667	**1089ab**	71.1	877.8	855.5	**668ab**
Omondaw	367	974	1033	**791cd**	177.7	733.3	822.2	**578b**
Bengsogla	406	733	878	**672d**	355.5	466.6	566.6	**422b**
Mean	**312.8b**	**1158.6a**	**1362.6a**		**147b**	**836a**	**849a**	

increased grain yields by at least 270% and 470% in 2005 and 2006 respectively (Table 6). There were no significant differences between 2 and 4 sprays for grain yield during both years.

The local varieties, *Omondaw* and *Bengsogla* supported significantly lower thrips populations than the improved varieties during both seasons (Tables 3 and 4). They also showed reduced infestation and damage by PSBs, even though in 2005, the differences were not statistically significant (Tables 3- 5). The data confirmed that the local varieties have lower yield potential than the improved, but under no insecticide protection, they (local) produced higher yields (Table 6). Insecticide application benefited the improved varieties most, with yield increases of 446 – 4900 % for Brown Eye compared with 31 – 81% for *Bengsogla* and 165 – 312 % for *Omondaw* during the two seasons.

Discussion

Results from these studies confirm the importance of insect pests as limiting factors to increased and sustainable cowpea production. Selective insecticide applications showed that *M. sjostedti* and PSB are the key pests of cowpea at the study site and control of these would be essential to guarantee sustainable production of the crop. *M sjostedti* is an important pest of the reproductive structures of cowpea, with early feeding leading to flower bud and flower shedding, hence poor pod set (Singh & Taylorl, 1978; Tamo et al 1993). There is therefore usually the need for farmers to apply insecticides during flowering to minimise such damage.

Protecting the crop with insecticide application increased yields several fold and for the improved varieties, virtually no yields were obtained under no insecticide protection. In fact, earlier studies by Tanzubil (1991**,** 2000) had concluded that in Northern Ghana, complete crop failure often results when improved cowpea varieties are grown without insecticide sprays. The results confirm the economic impact of chemical control in cowpea production and further show that with proper timing; two insecticide applications (at flowering and again at podding) could produce as good a cowpea crop as 4 sprays. This would be advantageous from the perspectives of lower costs and environmental pollution. The fact that neem extracts effectively reduced pest damage leading to increased yields confirms earlier reports by several authors (Jackai & Oyediran, 1991; Tanzubil, 1991, 2000) and raises hopes for incorporating biorationals in the management of cowpea pests.

None of the improved varieties showed significant levels of resistance to the key pests and in fact to combine resistance to all the cowpea insect pests in one cultivar would at best be an academic pleasantry (Jackai & Singh, 1983). The most promising option would therefore be to combine low levels of resistance with carefully timed minimum insecticide application. It is in this direction that the local varieties, *Omondaw* and *Bengsogla* seem to hold some promise and thus deserve closer study to establish more accurately the levels and mechanisms of resistance. There is also the need to explore more germplasm and materials from various sources to identify those that are less susceptible to the key pests. Though difficult to find, insect pest resistant varieties should form the basis for developing sustainable IPM systems for cowpea.

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