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Effect of cowpea cultivar, planting date and application of insecticide in the management of cowpea insect pests in South Eastern Sierra Leone

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Cowpea (*Vigna unguiulata*) is attacked by a wide spectrum of insect pests that ravages the crop in the field at different growing stages sometimes resulting in complete crop failure. In order to reduce insect pest damage, increase cowpea seed yield and reduce the indiscriminate use of insecticide, it was necessary to conduct an experiment geared towards integrating cowpea cultivar with date of planting alongside minimal application of insecticide in the management of cowpea insect pests across two major agro-ecological zones. The experiment was laid out in a randomized complete block design with three replications at three locations; Sumbuya, Serabu and Nguala. Five improved cowpea cultivars with varying maturity dates and one local check, two planting dates and two spraying regimes were compared. The study reveals that flower thrips (*Megalurothrips sjostedti)* and legume pod borers (*Maruca vitrata*) were the major insect pests limiting cowpea production in the country. Planting improve cowpea cultivars such as IT99k-573-1-1, IT99k-573-2-1, IT89KD-391 and IT97K-277-2 in mid-September coupled with three spraying regimes at budding, 50% flowering and 50% podding will improve grain quality and lead to an increase grain yield of between 60 and 62%.

Key words: Planting date, legume pod borer, flower thrips, grain yield, management.

INTRODUCTION

Cowpea is an important grain legume in West Africa and in many parts of the tropics throughout the world (Singh, 2005). It provides an inexpensive source of protein and minerals for the urban and rural masses of the region (Alabi et al., 2003). The grain is valued for its nutritive content and short cooking time, and the plant is especially favoured by farmers because of its ability to maintain soil fertility through its ability to fix nitrogen (Asiwe et al., 2009) and production of nutritious fodder for livestock. Under sole cropping, the potential grain yield is high between 1.5 and 3.0 t/ha, especially, when insecticide is applied (Ajeigbe et al., 2005). However, the actual yield obtained by farmers in Sierra Leone and other parts of West Africa are much lower averaging 25 to 300 kg/ha. Insect pests are considered to be largely responsible for this, as their attack can result in 90 to 100% yield reduction (Singh et al., 2000; Amatobi et al., 2005).

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In Sierra Leone, where farmer's seldomly use insecticides, the most damaging pests are flower bud thrips, *Megalurothrips sjostedti* Trybom. (Thysanoptera: Thripidae), the legume pod borer, *Maruca vitrata* Fab. (Lepidoptera: Pyralidae) and the pod sucking bug (PSB) complex of which *Clavigralla* species Stal. (Hemiptera: Coreidae), *Anoplocnemis curvipes* Fab. (Hemiptera: Coreidae), *Riptortus dentipes* Fab. (Hemiptera: Alydidae) and *Aspavia armigera* are the most damaging (Mansaray et al., unpublished). Attack by these insects is often so severe that farmers obtain no yields, especially when improved cowpea varieties are grown without insecticide protection. Consequently, this has limited the adoption of otherwise high-yielding varieties by resource-poor farmers.

For meaningful grain yield, control must be carried out (Suh et al., 1986) and the most reliable and effective control method is the application of synthetic chemicals. Reports have shown that the use of chemical insecticides can lead to yield increase of several folds (Jackai, 1993). However, insecticides are sometimes excessively and unwisely applied (Omongo et al., 1997) leading to environmental pollution (Alabi et al., 2003), toxicity to mammals, destruction of beneficial organisms such as predators and parasitoids. Other problems associated with chemical usage are cost of insecticides and equipment (Afun et al., 1991) which the peasant farmers cannot afford. These negative aspects of insecticides have necessitated into the development of integrated approaches to managing the cowpea pest complex so as to guarantee increased and sustainable production of this important crop. One promising combination would be the use of host plant resistance and planting dates alongside reduced insecticide application.

In many crops, the use of cultivars with moderate levels of resistance can cut down drastically on the amount and frequency of insecticides applied to control pests. Host plant resistance has been used as the principal tool for pest control in certain instance (Jackai et al., 1983). For example, the management of aphids and leaf hoppers can be achieved solely by the use of resistant varieties (Chari et al., 1976).

In recent years, planting date has been identified as an important component of integrated pest management practices (IPM). It has been suggested that adjustment of planting dates could cause asynchrony between crops and insect pests (Pedigo, 1989). For instance, in the Delmarva Region of the United States of America, early planting of cowpea in combination with application of insecticide resulted in a much higher grain yield than planting late (Javaid et al., 2005). Similarly, in Uganda, Karungi et al. (2000) reported that early planting reduced levels of infestation by aphids, thrips and pod-feeding bugs but increased levels of infestation by *Maruca.* Early sowing has also been reported to enable the crop to escape high temperatures during the flowering stage when the crop is sensitive to heat (Hall, 1992).

Little research has been done in Sierra Leone to study the response of improved cowpea cultivars to different frequencies of spraying with insecticides. The objective of this study was to evaluate the performance of improved cowpea cultivars under varying regime of insecticides spraying and planting dates across the major agro-climatic zones.

MATERIALS AND METHODS

Study area

The trials were conducted under rainfed conditions in 2012 and 2013 in Sumbuya and Nguala representing the forest transition and Serabu representing the forest zone. The soil in Sumbuya was sandy clay with 6.3% organic matter, P (olsen) 2.3 ppm, Exch. K 0.43 cmol/kg and pH of 5.2. In Serabu, the soil was also sandy clay with 2.3% organic matter, P (olsen) 5.4 ppm, Exch. K 0.26 cmol/kg and pH of 4.67. At Nguala, the soil was sandy clay with organic matter of 9.3%, P (oslen) 3.7 ppm, Exch. K 0.27 cmol/kg and a pH of 5.41. The prevailing rainfall at the three locations during the 2 years is summarized in Table 1.

Cowpea cultivars, planting dates, insecticide treatments and experimental design

Five improved cowpea cultivars with varying maturity dates were obtained from IITA for comparison with one local check, two planting dates and two spraying regimes were evaluated in a factorial randomized complete block design with three replications. The five improved cultivars were IT99k-573-1-1, IT99k-573-2-1, IT89KD-391, IT89KD-288, and IT97K-277-2 whilst the local cultivar was tabae. The insecticide spraying regime employed was: no spraying and spraying. Spraying was done once at flower bud initiation, 50% flowering and 50% podding. The time of planting was June and September. Prior to planting, the field was manually prepared with hoe and shovel. Plot size was 12 m^2 with each plot separated by 2-m alleys and covered with polythene sheets during spraying to protect the plots that were not sprayed. Planting was done in 2012 and 2013 at three locations, Sumbuya, Serabu and Nguala, respectively shown in Table 2. Three seeds of each cultivar were sown per hole with a spacing of 50 cm between rows and 20 cm within rows. The plants were later thinned to two plants per stands two weeks after planting to give a population of 200,000 plants ha^{-1}. For all treatments 270 g of SSP fertilizer was applied per plot at planting. For each spraying regime, a standard insecticide formulation, cypermethrin + dimethoate at the rate of 30 + 250 g a.i/L was applied with a 15 ml knapsack sprayer. 1 L of cypermethrin + dimethoate diluted in 150 L of water was used per hectare. A cone shaped nozzle was used with the spray directed downwards towards the plants. Weeding was done at 3 and 6 weeks after planting at all locations.

Assessment of insect infestation and grain yield

The four middle rows were used for data collection and sampling of insects in each plot. Ten days after each spray, 20 flowers were picked from the boarder row of each plot during the morning and were placed in vials containing 30% ethanol and brought to the laboratory to determine the number of flower thrips and legume pod borer (*Maruca*). The flowers were dissected; *Maruca* larvae and thrips nymphs and adults were identified and counted. The times of sampling varied with maturity period of the cowpea cultivar. For the

Table 1. Rainfall at the three locations during 2012 and 2013 cropping season.

Month	Rainfall per location (mm)					
	2012			2013		
	Location			Location		
	Sumbuya	Serabu	Nguala	Sumbuya	Serabu	Nguala
June	170.00	103.00	121.70	173.50	265.00	124.00
July	536.00	362.50	607.00	435.00	443.00	403.00
August	626.00	531.00	813.20	517.00	799.00	506.00
September	385.00	245.00	453.00	493.00	568.00	404.00
October	320.00	344.00	372.80	285.30	200.00	396.00
November	188.00	186.00	155.00	15.00	25.00	66.00
December	7.500	10.00	6.00	0.00	37.00	0.00

early (IT 99K-573-1-1 and IT 99K-573-2-1) and medium (IT 99KD-391 and IT99KD-288) maturing cultivars, counting began at about 6 weeks after planting; for the late-maturing cultivars (tabae), counting began at about 9 weeks after planting. Insects were counted twice at 10 day intervals, usually between 9 am and 12 noon. The four middle rows of each plot were harvested when pods of the first flush were mature and dry grain yield was reported on a 100% dry matter basis.

Data were subjected to analysis of variance (ANOVA) using the SAS statistical package (SAS Institute, 2014) and means were compared using the Student Newman-Keuls Test (SNK) at 0.05 level of significance. Data for insect counts were square root transformed (Steel and Torrie, 1980) before analysis.

RESULTS

Number of thrips per flower

The number of thrips per flower varies significantly (P<0.05) with respect to time of planting, spray regime and cowpea cultivar during the two cropping seasons (Table 3). The population of thrips per flower was significantly higher (P<0.05) in all non-sprayed plots compared to sprayed plots across the two planting dates and at all locations during the two cropping seasons. The number of thrips in the no spray plots was 97% and 53% higher when planting was done in June and September respectively compared to the sprayed plots (Table 3). The number of thrips per flower was 44% higher when cowpea was planted in June (1.42) than when planted in September (0.92). The local variety recorded a significantly (P<0.05) higher number of thrips per flower across planting dates and spraying regimes. When planting was done in June, variety IT89KD-391, recorded the least number of thrips per flower. Differences in the number of flower thrips per flower among the other cultivars (IT89KD-288 and IT97K-277-2) were not significant. In September, IT89KD-391 also recorded the least number of thrips per flower. Furthermore, the three-way interactions between cowpea cultivar, planting date and spraying regime with respect to the number of thrips per flower was significant (P<0.05).

Number of *Maruca* per flower

Similarly, the number of *Maruca l*arvae (larvae were not separated into instars) per flower were significantly (P<0.05) different for cowpea cultivar, planting dates and spraying regime. In general, the number of *Maruca* per flower was low across all planting dates and spraying regime with sprayed plots recording the least number of *Maruca* per flower across cowpea cultivar and planting dates (Table 4). The number of M*aruca* larvae per flower was observed to decrease after each spraying regime. The number of *Maruca* per flower was 49% higher when planting was done in June (0.77) compared to September planting date (0.39). With respect to cowpea cultivar, the local cultivar tabae, again recorded the highest number of *Maruca* per flower compared to the improved cultivars across the two planting dates and spraying regimes. When planting was done in June, no significant differences were rerecorded in the number of *Maruca* per flower between IT99K-573-2-1 and IT89KD-391 and between IT97K-277-2 and IT89KD-288.

When planted in September, no significant differences were recorded in the number of *Maruca* per flower among IT99K-573-1-1, IT99K-573-1-2 and IT97K-277-2 and between IT89KD-391 and IT89KD-288 (Table 4). In addition, the three-way interactions between cowpea cultivars, time of planting and spraying regimes with respect to the number of *Maruca* per flower was also significant (P<0.05).

Grain yield

Cowpea cultivar, spraying regime and time of planting significantly influenced cowpea grain yield. When planted in June, IT99K-573-1-1 recorded the highest grain yield (658.03 kg/ha) whilst tabae the local cultivar recorded the least (360.01 kg/ha). There were no significant differences in grain yield between IT89KD-288 and IT97K-277-2 and between IT99K-573- 2-1 and IT99K-573-2-1 (Table 5). In September, IT99K-573-1-1 (952.39 kg/ha) also recorded the highest grain yield.

Table 2. Planting date with respect to year and location.

Planting date	Location	Year
First planting		
7th June	Sumbuya	2012
9th June	Serabu	2012
12th June	Nguala	2012
Second planting		
14th September	Sumbuya	2012
14th September	Serabu	2012
16th September	Nguala	2012
First planting		
14th June	Serabu	2013
15th June	Sumbuya	2013
19th June	Nguala	2013
Second planting		
21st September	Serabu	2013
25th September	Sumbuya	2013
25th September	Nguala	2013

Table 3. Effect of cultivar, spraying regime and planting date with respect to number of thrips /flower.

Planting date	Cultivar	Number of thrips/flower		Mean
		Spraying regime		
		Sprayed	No-sprayed	
June	IT99K-573-1-1	0.44	1.38	0.91^{d}
	IT99K-573-2-1	1.02	2.27	1.64^{b}
	IT89KD-391	0.24	2.07	1.15^{c}
	IT89KD-288	0.52	1.74	1.13^{c}
	IT97K-277-2	0.67	1.82	1.24^{c}
	Local (tabae)	1.52	3.45	2.48^{a}
	Mean	0.73^{b}	2.12^{a}	1.43^{a}
September	IT99K-573-1-1	0.35	1.22	0.78^{b}
	IT99K-573-2-1	0.46	1.02	0.74^{b}
	IT89KD-391	0.40	0.66	0.53^{c}
	IT89KD-288	0.50	1.00	0.75^{b}
	IT89KD-277-2	0.51	1.10	0.81^{b}
	Local (tabae)	1.80	2.00	1.90^{a}
	Mean	**0.67^{b}**	**1.16^{a}**	**0.92^{b}**

Means in column with the same letter are not significantly different at P>0.05 (SNK)

Grain yield ranged from 435.38 kg/ha for the local cultivar tabae to 952.39 kg/ha for IT99K-573-1-1. Grain yield was 35% higher when planting was done in September (763.79) compared to when planting was done in June (534.76). For spraying regime, grain yield was 60 and 62% higher in June and September, respectively in sprayed plots compared to no-sprayed plots.

DISCUSSION

The present study has confirmed the importance of insect pests as the limiting factor for increased cowpea production in Sierra Leone. Results showed that thrips, pod sucking bugs and legume pod borer are the key pests that limit cowpea production. This is consistent with

Table 4. Effect of cultivar, spraying regime and planting date with respect to number of *Maruca*/ flower.

Planting date	cultivar	Number of *Maruca*/flower — Spraying regime — Sprayed	No-sprayed	Mean
June	IT99K-573-1-1	0.64	0.93	0.78[b]
	IT99K-573-2-1	0.32	0.42	0.37[c]
	IT89KD-391	0.46	0.69	0.57[c]
	IT89KD-288	0.54	0.92	0.73[b]
	IT97K-277-2	0.61	0.93	0.77[b]
	Local (tabae)	1.14	1.76	1.45[a]
	Mean	0.61[b]	0.94[a]	0.77[a]
September	IT99K-573-1-1	0.17	0.31	0.24[c]
	IT99K-573-2-1	0.21	0.28	0.24[c]
	IT89KD-391	0.41	0.35	0.38[b]
	IT89KD-288	0.35	0.35	0.35[b]
	IT97K-277-2	0.21	0.38	0.29[c]
	Local (tabae)	0.74	0.94	1.84[a]
	Mean	0.34b	0.43[a]	0.39[b]

Means in column with the same letter are not significantly different at P>0.05 (SNK).

Table 5. Effect of cultivar, spraying regime and planting date with respect to grain yield.

Planting date	Variety	Grain yield (kg/ha) — Spraying regime — Sprayed	No-sprayed	Mean
June	IT99K-573-1-1	829.92	486.13	658.03[a]
	IT99K-573-2-1	709.80	362.14	535.97[c]
	IT89KD-391	711.98	309.70	510.84[c]
	IT89KD-288	716.02	439.00	577.86[b]
	IT97K-277-2	822.96	334.47	578.72[b]
	Local (tabae)	377.94	317.08	360.01[d]
	Mean	694.77[a]	374.76[b]	534.76[b]
September	IT99K-573-1-1	1,281.18	623.61	952.39[a]
	IT99K-573-2-1	1,032.45	710.26	871.36[b]
	IT89KD-391	1,030.91	545.87	788.39[d]
	IT89KD-288	926.36	433.02	679.69[e]
	IT97K-277-2	1,165.23	545.86	855.54[c]
	Local (tabae)	538.73	332.04	435.38[f]
	Mean	995.81[a]	531.77[b]	763.79[a]

Means in column with the same letter are not significantly different at P>0.05 (SNK).

findings of other authors elsewhere in Africa. For example, Amatobi (1994), Karungi at al. (2000) and Kyamanywa (1996) all reported that thrips are one of the yield limiting pests to cowpea production. The result suggests significant differences in the number of thrips and legume pod borer *(Maruca)* per flower among insecticide treatments with more damage occurring in the non-treated plots compared to the treated plots. This observation is in agreement with Amatobi (1995) and Alghali (1992) who reported that spraying insecticide against cowpea insect pest can reduce damaged at flowering stage and therefore result into increase in yield.

Other studies in West and East Africa have found that the application of insecticides significantly reduced insect pest populations and increase grain yield of cowpea (Karungi et al., 2000; Kamara et al., 2007). Flower thrips are important pests of cowpea with early feeding leading to floral abortion and poor pod set (Tamo et al., 1993).

The effect of insecticides on the population of thrips and *Maruca* in the study was however, dependent on the date of planting as more thrips and *Maruca* per flower were recorded when planting was done in June compared to September planting date. The reason for the above observation could be related to the fact that cowpea planted in June will flower in August a period of high rainfall and low temperature which provides a good micro environment for the development of larvae of these pests. This result agrees with the findings of Alghali (1991, 1992) who also associated increase in pest pressure in cowpea in West Africa with high rain fall. The result further suggests that improved cowpea varieties (ITK-573-1-1, ITK-573-2-1, IT89KD-391, IT 80KD-288 and IT 90K-277- 2) had significantly lower insect pests count than the local cowpea cultivar tabae. This lower insect pest on plots with improved cultivars shows that they were more resistant to the pests than the local cowpea cultivar consistent with reports by Kamara et al. (2007).

Grain yield, differ significantly with cowpea cultivar with the improved cultivars out yielding the local cultivar. The reasons for the higher grain yield could be related to the ability of the improved cultivars to flower profusely and also on their high podding ability which compensated for insect damage. Jackai et al. (1989) reported that the damage inflicted on the cowpea plant is known to stimulate compensatory flowering and pod production in the early flowering and podding cultivars like ITK-573-1-1, ITK-573-2-1, IT89KD-391, IT 80KD-288 and IT 90K-277-2 than the late flowering and podding local cultivar like tabae.

Another reason could be due to the high pest load on the local cultivar which could be attributed to the long reproductive phase which synchronized with the peak population of the insect pests (Amatobi, 1995).

Also, grain yield differs significantly with respect to insecticide application. Grain yield was consistently higher in the treated plots than the non-treated plot. This result is consistent with the findings of Karungi et al. (2000). These authors reported that the application of insecticides generally reduces cowpea insect pest infestation thus markedly increasing crop yield and the other yield related components. Studies elsewhere have also reported marked increased in yield following the application of insecticide to control insect pests of cowpea. For example, Price et al. (1983) obtained increased seed yield in Tanzania by the use of deltamethrin, monocrotophos, dimethoate and endulfan at both the pre- and post-flowering phases. Also, Dina (1988) reported increased seed yields from cowpea in Nigeria by the use of six insecticide sprays after the onset of flowering. Furthermore, Kyamanywa (1996) in Kenya got a 15-fold increase in grain yield after the application of insecticide.

The three sprayed regime plots recorded the highest grain yield compared to the no sprayed plot. This result corroborates with the findings of Karungi et al. (2000); these authors reported that insecticide application once each at budding, flowering and podding resulted in the highest marginal returns higher than applying insecticide once each at vegetative stage, flowering and podding stages or spraying throughout the season. Also, several other authors such as Ajeigbe and Singh (2006) and Kamara et al. (2010) have also noted that three strategic insecticides sprays are effective in the control of insect pest of cowpea. The yield increase may be due to the successful control of flower thrips when spraying once at flowering and thrips, legume pod borer and pod sucking bugs when spraying once each at flowering and podding stages. It has also been shown that a significant gain in yield can also be achieved by one spray at flowering as 70% of the total yield loss in cowpea production occurs due to insect's damage to the flowering and pod formation stages (Karungi et al., 2000).

The result also shows that cowpea planting date influences yield as yields were higher when planting was done in September compared to planting cowpea in June. The reason for this could be related to the high flora abortion due to rain fall as cowpea planted in June will flower in August which is the month that accounts for the heaviest rainfall in the country. The high rainfall will also increase humidity within the canopy which provides a conducive environment for the development of the larvae of *Maruca* and pod sucking bugs. Thus, for effective management of cowpea insect pests leading to increase in yield, farmers should plant improved cowpea varieties in September and applied insecticide at flowering and podding stages.

Similar recommendation was made by Karungi et al. (1999). This author reported that cowpea management practices that involve combination of planting dates, close spacing alongside minimum insecticide application was most effective in reducing pest infestation in Uganda.

Conclusion

The study indicates that flower thrips and legume pod borers are the major limiting factors to cowpea production in Southern and Eastern Sierra Leone. The population of insect pests were lower in all sprayed plots compared to unsprayed plots thus resulting into an increase in yield of between 60 and 62%. The study also shows that higher yields and better grain quality were obtained when planting was done in September compared to June. Also the improved cowpea varieties out yielded the local variety tabae at all spraying regimes indicating that they were less susceptible to insect pests compared to the local variety and as such could be recommended to farmers for cultivation.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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