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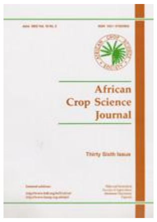

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Pests and diseases on cowpea in Uganda: Experiences from a diagnostic survey

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ABSTRACT

A diagnostic survey (DS) using a questionnaire covering 525 farm households was conducted in 1993/94 to determine the status of cowpea (Vigna unguiculata L. Walp) and its production constraints in Uganda. Subsequent on-farm assessments were made during the two rainy seasons of 1994 to verify and quantify the survey information. Additionally, on-station trials were conducted to address issues arising from the information. Insect pests, low plant population densities, poor weed management and labour bottlenecks are the most important constraints to cowpea production in Uganda. Insect pest damage, particularly by bruchids, is most important. Research to develop integrated pest management (IPM) strategies based on the finding of this study are in progress.

Key Words: Farmer perception, integrated pest management, on-farm surveys, production costs, profitability, Uganda, Vigna unguiculata

RÉSUMÉ

Une enqu • te diagnostique (ED) utilisant un questionnaire couvrant 525 ménages a été conduite en 1993/94 pour déterminer la situation du niébé (Vigna unguiculata L. Walp) et ses contraintes de production en Uganda. Par suite des évaluations en milieu réel ont été faite pendant deux saisons pluvieuses de 1994 pour vérifier et quantifier les résultats de l'enquête. En plus, des essais en station ont été conduits pour addresser les problèmes indiqués par l'enquête. Les pestes d'insectes, les faibles densités des populations des plantes, la pauvre gestion du sarclage et le goulot de la main d'oeuvre sont les plus importantes constraintes de production du niébé en Uganda. Demage de pestes d'insectes, particulicrèment par les bruches, est le plus important. La recherche pour développer des stratégies de la gestion intégrée des pestes (IPM) basées sur les résultats de cette étude est en cours.

Mots Clés: Perception des agriculteurs, gestion intégrée des pestes, enquêtes en milieu réel, rentabilité, Uganda, Vigna unguiculata

Introduction

Cowpea (*Vigna unguiculata* L. Walp) is an important source of protein to the people of northern and eastern Uganda, where about 90% of the country's crop is grown (Sabiti *et al.*, 1994). The leaves, green pods and dry grains are consumed. The crop is grown under low-input conditions and grain yields are low, averaging less than 500 kg ha^{-1} (Sabiti *et al.*, 1994).

Local production systems are not well-documented. However, scantly information from research stations in central Uganda indicates that pests are a major constraint (Koehler and Mehta, 1972; Mehta and Nyiira, 1973) and has not been verified on smallholder farms. Market surveys on the other hand reveal that cowpea fetches the second highest price among legumes grown in the country but production appears to be declining nationally, although cultivation of the crop seems to be on the increase in some districts of eastern Uganda.

In response to the increased demand for cowpea in the country, scientists of the Uganda National Agricultural Research Organisation (NARO) and Makerere University, began research on cowpea in 1993. As a basis for designing a research agenda for the crop (Byerlee and Collinson, 1980) we report here results from a systematic survey of the status of cowpea in Uganda and farmer perception of production constraints. We then focus on farmers most important production constraint, i.e., pests. Finally, the paper suggests possible areas for follow-up studies, some of which have been or are being implemented (see Isubikalu *et al*., 1999; Nampala *et al*., 1999b; Karungi *et al*., 1999; Karungi *et al*., 2000a, b).

Methods

Five hundred and twenty five farm households from the major cowpea growing districts of Arua, Nebbi, and Lira in the northern region, and Soroti, Kumi, Pallisa and Tororo in eastern Uganda were interviewed (Fig. 1). Selection of farmers was based on systematic multi-stage random sampling, and total area occupied by cowpea in each district. Three counties in Soroti and two each in Kumi, Pallisa, Arua, Nebbi and Lira were covered during the survey.

In each county, data were collected from one sub-county chosen by lot. One sub-parish was selected at random from each of the parishes in the selected counties. Using the local administrative register, 35 farm households were then randomly selected from each of the selected sub-parishes, and interviewed. Although selection of households was random, attempts were made to interview female and male headed households separately, and respondents of different age groups. A multi-disciplinary structured questionnaire, designed to assemble information on socioeconomic variables, production statistics, cropping systems, pest and disease occurrence, seasonal variation, farmer's methods of pest control as well as cowpea agronomy was used as the survey instrument.

A subsequent on-farm assessment was implemented to verify and quantify survey information and to gather additional information. Because of their perceived importance (pests) and scarcity of information (diseases), emphasis was placed on pest and disease factors. Assessments were made in the same localities used for the diagnostic survey, but no survey was conducted in Tororo and Lira in the first rains (season) of 1994 because cowpea is not grown in these districts in this season. Ten farmers from the major cowpea growing parishes were randomly chosen from one sub-county per county. Ninety cowpea fields were surveyed during the first season and 110 during the second season.

Each field was visited three times between May and late July in the first season and September and November in the second season of 1994. The three visits corresponded to the early vegetative stage (2-3 weeks after emergence), flowering/podding, and pod maturity stage. At each visit, 10 plants in each field, spaced about 10 m apart along a transect, were inspected for insect and disease infestation.

At an early vegetative stage the incidence and population of aphids (*Aphis craccivora* Koch) were recorded based on visual inspection scores (Ogenga-Latigo *et al.*, 1992a). Population densities of foliage beetles (*Ootheca* sp.), and of thrips *(Megarulothrips sjostedti* Trybom*)*, and legume pod borer *(Maruca vitrata* Fab.*)*, infesting flowers were also assessed. Similarly, at flowering and podding stages, counts were made of the different pod sucking bug species. Damage by pod sucking bugs and Maruca was assessed by examining cowpea seeds from dry pods at harvest.

Disease severity (percent plant area affected) of the major diseases affecting cowpea was also assessed on a random sample of 10 plants per field per visit using a modified scale of Horsfall and Barret (1945). Details of the sampling techniques for disease and insect damage are given respectively by Edema *et al*. (1997) and Omongo *et al.* (1997). The cropping systems (mixed cropping vs monocropping) and cultivars grown were noted. Mean plant populations at planting and harvest were obtained by averaging the plant population in four 1 m x 1 m quadrats. When plants were mature and dry, grain yield was determined using four quadrat samples.

Data analysis. Appropriate, analyses of variance (ANOVA) were conducted using the MSTAT-C computer package. Severity of different diseases were also related to plant population by correlation analysis, while marginal productivity (Alghali, 1992; Sabiti, 1995) was employed to determine returns to investments in cowpea production.

Results and Discussion

Socioeconomic factors affecting cowpea production. Although the relative amount of land devoted to cowpea and other crops appeared low (Table 1), the major hindrance seemed to be lack of labour for land preparation and weeding (data not presented). In Pallisa, however, there was general land shortage. Our findings also indicated that farmers producing for market used different cultivars, that were sole cropped, and sprayed with pesticides on a regular basis. These farmers also had more land in cowpea production and were more likely to be using mechanical (animal traction or tractors) means to cultivate fields. Women farmers indicated that they grew specific cultivars for harvesting the leaves and exhibited a greater reluctance to use chemical pesticides.

Table 1. Percentage of total farm hectarage sown to cowpea in five districts of Uganda[a]

District	Proportion of farm sown to cowpea		Intercropping		Sole cropping	
	ha.	% total hectarage	ha.	%	ha.	%
Soroti	0.58	29.0	0.24	41.4	0.34	58.1
Kumi	1.04	65.0	0.50	48.1	0.54	51.9
Pallisa	1.07	59.4	0.31	29.0	0.76	71.9
Nebbi	0.25	10.4	0.20	80.0	0.05	20.0
Arua	0.20	20.0	0.35	58.3	0.25	41.7

[a] Data for major cowpea growing areas; cowpea heactarage is significantly lower for other areas

In Kumi and Pallisa where there is extensive commercial cultivation of cowpea there was clear gender division of cowpea fields with the majority of the cowpea crop for sale being grown by men and that for home consumption by women. Commercial growers preferred large seeded cultivars, that were white or black (reportedly has higher oil content). They also tended to weed their fields more timely and regularly, and used pesticides extensively but not rationally. In these areas cowpea is now considered an important cash crop.

Tables 2 and 3 show the cost of production and some of the profitability indicators of cowpea production under different production techno-logies. The returns to labour in all cases is higher than the average rural wage rate (Ug. Shs. 600 per man day). This underscores the fact that cowpea production is not a labour intensive enterprise. A comparison was made of the cost of production and the profitability of cowpea production with that of groundnut, which is the most important competing crop, and that of cotton, which is the most important traditional cash crop, in the study area (Table 4). Although groundnut production has a higher net income compared to cowpea production, the latter has a lower cost of production and a higher returns to labour. Cotton production has a negative net income due to the extremely low producer price offered to farmers for this crop. Cowpea competes even better against other legume crops. Thus, cowpea is an important crop in Uganda and, therefore, deserves more research attention than it is currently receiving.

Table 2. Marginal productivities of various inputs in cowpea production in Uganda (Sabiti, 1995)

Variable	Unit	MP[a]	VMP[b] Ushs)
Land	Ha	385.5	154,300
Labour	$MDha^{-1}$	0.72	288
Pest control	Ush ha^{-1}	0.0004	0.16

[a]MP = Quantitative (kg) increase in cowpea production per unit increase of the input
[b]VMP = MP x average rural price of cowpea (Ush. 400 kg-1; 1US$ = Ug Sh 940)

Table 3. Cost of production, gross margin and returns to labour for production of cowpeas[1]

Cost component	Ox plough (with spray)	Ox plough (without spray)	Hand hoe (with spray)	Hand hoe (without spray)
Cost of production (Sh/kg)	123	176	126	181
Gross Margin (USh ha^{-1})	267,500	143,750	268,250	144,500
Returns to labour (Ush/man day)	4,053	2,522	2,580	1,521
Net income (USh ha^{-1})	207,900	89,550	205,850	87,500

[1]Average cowpea price = USh 400 (1US$ = USh. 940)

Table 4. Comparison of profitability of cowpea production with profitability of cotton and groundnuts - 1995[1]

Measure	Cowpea	Groundnut	Cotton[2]
Cost of production (USh ha^{-1})	126	335	343
Gross margin (USh ha^{-1})	268,250	387,500	76,345
Returns to labour (USh M-d)	2,580	1,502	385
Net income (USh ha^{-1})	205,850	293,600	-28,400

[1] Hand hoe with spray scenario is used
[2]Source: Bank of Uganda Agricultural Secretariat

Table 5. Relative importance of cowpea pests in Uganda based on percentage of farmers reporting them

	District				
Pest	**Soroti**	**Pallisa**	**Lira**	**Arua**	**Overall means[a]**
*Aphids[b]	22.3	22.5	21.7	18.5	21.3(2)
*Grasshoppers	4.1	0.7	1.9	4.8	2.9(9)
*Fire fly' (defoliator)	12.8	14.6	8.5	9.7	11.4(3)
**Thrips	2.7	5.3	0.0	1.6	2.4(10)
**Pollen beetles	6.1	5.3	3.8	2.4	4.4(8)
**Pod bugs	7.4	10.6	18.9	7.3	11.1(4)
**Pod borers	6.8	7.3	5.7	10.5	7.6(6)
*Termites	5.4	5.3	2.8	9.7	5.8(7)
*Bruchids	20.9	20.5	28.3	18.5	22.1(1)
*Vertebrate pests	10.2	7.9	7.5	15.3	10.2(5)
No idea	1.3	0	0.9	1.7	1.0

[a] Overall ranking in parentheses
[b] * very visible; ** less visible

Pests status. Farmers in all the survey sites ranked insect damage, especially bruchids, as the most important constraint in cowpea production. Their perception of pest problems (Table 5) corresponded fairly well with our observations. *Aphis craccivora*, *Maruca vitrata*, *Megalurothrips sjostedti* and the pod sucking bugs (particularly *Clavigralla* sp., *Nezara viridula* and *Riptortus* spp.) were the most common field pests. Their occurrence, abundance, and damage varied considerably among the locations, varieties, cropping systems and growing seasons (Tables 6, 7, 8).

Table 6. Seasonal variation of major pests of cowpea as judged by farmers' responses (%)

	District			
Pest	Soroti	Pallisa	Arua	Lira
Aphids				
First season (1st)	18.2	41.2	21.7	47.8
Second season (2nd)	33.3	32.4	65.2	8.7
Both 1st and 2nd	48.5	23.5	4.3	39.1
'Fire fly				
First season (1st)	68.4	59.1	66.7	41.7
Second season (2nd)	5.3	18.2	-	-
Both 1st and 2nd	26.3	22.7	11.1	16.7
Pod bugs				
First season (1st)	36.4	50	40	77.8
Second season (2nd)	27.3	31.3	30	-
Both 1st and 2nd	27.3	12.5	10	11.1
Pod borers				
First season (1st)	30	63.6	66.7	30.8
Second season (2nd)	50	27.3	-	-
Both 1st and 2nd	20	-	-	53.8

- pest not reported

Table 7. Comparison of insect numbers and damage on cowpea in different districts of Uganda

Insect pests and damage	Soroti	Kumi	Pallisa	Nebbi	Arua	Lira	Tororo	Mean
Insect pests				**First season (April-July) 1994**				

Maruca 10 plants^{-1}	1.5b	6.7a	5.6a	1.1b	1.8b	[a]	-[a]	3.3
Bugs 10 plants^{-1}	0.5b	2.4b	4.5a	1.2b	1.2b	-	-	2.0
Ootheca 10 plants^{-1}	1.7a	0.8bc	0.2c	0.2c	1.0ab	-	-	0.8
				Second season (September - December) 1994				
Thrips 20 flowers-1	247.7ab	150.5bc	86.5bc	185.8ab	272.6a	84.8c	165.3bc	170.4
Maruca 20 flowers-1	0.9c	5.7b	1.7c	0.9c	1.9c	0.6c	12.7a	3.5
Bugs 10 plants^{-1}	6.3a	6.8a	3.7a	4.4a	3.4a	5.2a	5.7a	5.1
Ootheca 10 plants^{-1}	0.3a	0.0a	0.7a	0.7a	0.2a	0.0a	0.0a	0.3
Damage				**First season (April-July) 1994**				
Pod damage	4.9c	13.2ab	10.5b	15.6a	12.8ab	-	-	11.4
Seeds eaten	5.2b	10.4a	6.7ab	3.8b	6.7ab	-	-	6.5
Shrivelled seeds	11.9a	11.9a	8.8a	8.2a	10.3ab	-	-	10.2
				Short season (September-December) 1994				
Pod damage	10.3bc	12.2bc	13.9bc	17.3bc	8.2c	-[b]	28.1a[c]	14.9
Seeds eaten	13.4a	4.7a	3.3a	3.1a	3.3a	-	2.2a	3.3
Shrivelled seeds	10.6c	14.3bc	12.1bc	20.0ab	25.4a	-	12.6bc	15.9

[a]: Cowpea not grown in Lira and Tororo during the first season
[b] : data not taken
[c]a,b,c: Means in the same row followed by the same letter(s) are not significantly different at P$\leq$ 0.05 using LSD test

Table 8. Pest incidence on six common cowpea varieties grown in Uganda[a]

Pest	*Icirikukwai*	*Amul*	*Ebelat*	*Osunyiri*	*Kisyanka*	*Apee*	Mean
First rains (April-July) 1994							
Aphids incidence (%)	68.9a[b]	67.5a	53.0a	31.0b	-[c]	-[c]	55.1
Maruca 10 plants^{-1}	6.2a	1.7b	0.9b	0.8b	-	-	2.3
Bugs 10 plants^{-1}	3.3a	0.6b	1.2b	1.2b	-	-	1.6

Ootheca 10 plants^{-1}	0.6b	1.7a	0.8b	0.2b	-	-	0.8
Second season (September-December) 1994							
Aphid incidence (%)	15.3d	34.7b	19.0cd	33.0bc	9.0d	70.0a	30.2
Thrips 20 flowers-1	165.6bc	142.0bc	185.8b	270.3a	165.3bc	84.8c	169.0
Maruca 20 flowers-1	3.5b	1.6b	0.9b	1.9b	12.8a	0.6b	3.6
Bugs 10 plants^{-1}	4.9a	5.9a	4.4a	3.4a	6.4a	5.2a	5.0
Ootheca 10 plants^{-1}	0.4a	0.3a	0.7a	0.2	0.0a	0.2a	0.3

[a]Mean of 10 plants per field for 90 and 110 different fields during the first and second seasons, respectively
[b] a,b,c: Means in the same row followed by the same letter(s) are not significantly different (P=0.05) using LSD test
[c] Cowpea varieties not grown during first rains

The results of the diagnostic survey and on-farm assessments leave no doubt on the status of *Aphis craccivora* as the main vegetative insect pest of cowpea in Uganda. Total crop failure occurred in Lira and was attributed, in part, to aphid depredation. At 2-3 weeks after cowpea emergence more than 30% of the cowpea plants already had a high population density of 100-300 aphids plant-1. Singh and van Emden (1979) also observed heavy aphid infestations on cowpea at seedling stage which led to total destruction of the crop.

Although farmers' perceptions varied on the seasonal dynamics of aphids, on-farm assessments revealed more aphid problems in the first than in the second season at all the sites. A similar observation has been made for bean aphids, *Aphis fabae*, in Uganda (Oonyu, 1992), but serious aphid problems on other legumes have been reported mainly in the second season (Ingram, 1969; Night, 1993). Our study and those of Oonyu (1992) and Night (1993), were done over only 2 to 3 seasons. Therefore, long term data, over several years, would probably show better seasonal fluctuation of aphid population in many legume crops. The contrasting situations noted in many sites in the present study could be due to differential rainfall intensities during the sampling periods. The observation of Srikanth and Lakkundi (1990) that the intensity and impact of rainfall have more influence on aphid number than do the average rainfall amounts, seem to support the trend observed in this study.

Absence of 'fire fly' (*Dacus* sp.) during the on-farm assessment cast doubts on status of 'fire fly' as the main cowpea defoliator. Two species of foliage beetles (*Ootheca mutabilis* and *O. bennigseni*) were commonly found on cowpea plants. Although Ootheca is a sporadic pest, high population can lead to complete defoliation of cowpea seedling, resulting in the death of the plant (Singh and Jackai, 1985). It is likely, therefore, that farmers are not conversant with the devastating effects of the two Coleopteran beetles.

Pest assessments on farmers' fields revealed high thrips and Maruca levels in many sites, although these pests were considered minor by farmers (Table 5), probably because of the hidden nature of the pests. Furthermore, the population density of more than 10 thrips flower-1 recorded in some sites is a concern, given that a population density of 20 thrips flower-1 caused total loss of grain yield in cowpea (Okwakpam, cited by Kyamanywa, 1988).

The present study revealed that Maruca attacked cowpea in greater numbers in the first season than in the second season (Table 6). In general terms, higher pod damage by Maruca corresponded with higher seed damage, but this was not true for Nebbi and Tororo where seed damage was low despite the high pod damage. This may be due to differential varietal reactions to Maruca attack, although environmental factors may have been important.

Pod sucking bugs appeared to be more problematic in the second season than in the first. The average bug number of 5.1 per 10 plants registered in the second season is above the threshold of 2 and 4 bugs per 10 plants at flowering and podding, respectively (Jackai *et al*., 1989). While threshold levels may vary from place to place, the present results suggest that pod sucking bugs are a serious pest of cowpea in Uganda, especially during the second rains when most cowpeas are grown. The low level of seed shrivelling recorded on *Icirikukwai* throughout the study period seem to suggest varietal influence on the extent of bug damage.

Levels of some pests were not affected by cropping system but the lower levels of Maruca and thrips with intercropping may be useful in developing integrated pest management (IPM) strategies. Maruca and thrips levels were generally lower in the intercrop than in the monocrop (Table 8) which collaborated the findings of other workers that these pests are suppressed by intercropping (Karel *et al*., 1980; Kyamanywa and Tukahirwa, 1988). This reduction in pest incidence and damage is advantageous in that it may result in increased crop yield or reduced cost of control. However, not all crop combinations are effective in reducing pest infestations. For example, Kyamanywa and Tukahirwa (1988) found no advantage of mixing cowpea with beans with respect to reduced thrips infestation. Empirical studies to obtain effective crop combinations are needed to provide viable control tactics for smallholder cowpea farmers.

Insecticide use is a likely component of an IPM strategy, and possibly essential for successful cowpea commercial production (Jackai *et al*., 1985). Over 20% of the farmers in eastern Uganda used insecticides (Table 9, see also Omongo *et al*., 1998) to control cowpea pests, with as many as six applications per season, but use was not based on action threshholds (Jackai *et al*., 1989; Isubikalu *et al*., 1999). The environmental effects of insecticide use on pollinators and predators in Uganda are not known and there may be harmful effects on persons eating the green leaves and pods.

Table 9. Influence of the two cropping systems on abundance and damage of major insect pests of cowpea

	Cropping system[1]		
Pest and grain damage	Sole	Intercrop	Mean
Pest	**First season (April-July) 1994**		
Maruca 10 plants^{-1}	6.8a[2]	3.1a	4.9
Bugs 10 plants^{-1}	1.6a	3.4a	2.5

Ootheca 10 plants^{-1}	1.2a	1.0a	1.1
	Second season (September-December) 1994		
Thrips 20 flowers-1	150.1a	141.3b	145.7
Maruca 20 flowers-1	4.5a	1.4b	2.9
Bugs 10 plants^{-1}	4.6a	5.9a	5.2
Ootheca 10 plants^{-1}	0.9a	1.1a	1.0
Pod and seed damage	**First season (April-July) 1994**		
% Pod damaged	10.0a	12.2a	11.1
% Seed eaten	6.9a	9.5a	8.2
% Shrivelled seeds	11.0a	10.6a	10.8
	Second season (September-December) 1994		
% Pod damaged	15.3a	10.1b	12.7
% Seed eaten	3.5a	4.1a	3.8
% Shrivelled seeds	16.7a	16.6a	16.6

[1]Mean of 10 plants per field for 90 and 110 different fields during the first and second seasons, respectively; for the intercrop pooled data of cowpea/cassava/sorghum/green gram
[2]a,b: Means on the same row followed by the same letter are not significantly different at $P \leq 0.05$ using LSD test

The economic viability of pesticide application also appears doubtful. For example, Sabiti (1995) has assessed the relative contribution of key inputs to cowpea production using marginal productivity (MP) and value marginal productivity (VMP) analysis. The MP of an input in cowpea production refers to the quantitative increase in cowpea production expected given a unit increase in the input. And, VMP is the monetary value of the increase in cowpea production expected as a result of a unit increase of an input. In the case of this study the VMP is obtained by multiplying the MP by the then prevailing average rural market price of cowpea (400 Ug. Shs. kg-1; 1US$ = 940 Ug. Shs.). Table 2 indicates that an increase of 1 hectare of land in the production of cowpea increases the returns to the farmer by Uganda shillings 154,300. The VMP of labour was Ug. Shs. 288 for every person day per hecatare increase in cowpea production. The VMP of pest control chemicals was, however, only Ug. Shs. 0.16. This means that farmers make a loss for every Uganda shilling invested in pest control. This might be related to our observation during the DS and on-farm surveys that there was gross misuse of pesticides. Thus, substantial amount of background information is required in order to use insecticide in an economic and environment friendly way. The timing of insecticide application, rate and frequency of application are some of the aspects that require urgent attention on cowpea entomology in Uganda.

Most farmers interviewed, except those engaged in production for exogenous markets, indicated that post-harvest storage of cowpea was a major problem, because of bruchid infestation. Their main strategy for dealing with this problem was to sell or consume cowpea immediately after harvest. This invariably leads to shortage of planting seed the following season. Storage management strategies to minimise bruchid damage should, therefore, be a priority research area in Uganda. Resistant lines are available (from International Institute of Tropical Agriculture (IITA)) which should be tested in Uganda. Indigenous strategies in use include; use of wood-ash, castor oil, and storage in pods.

Disease status. Except for viral diseases, rusts (*Synchytrium dolichi* and *Uromyces appediculatus* var. *vignicola*), and scab (*Sphaceloma* sp.), few farmers recognised disease symptoms or considered them important (Edema, 1995). Nevertheless, total crop failures due to scab and yellow blister disease have occurred at Makerere University Agricultural Research Institute, Kabanyolo, Serere Agricultural and Animal Production Research Institute and during the on-farm surveys.

Bacterial blight (*Xanthomonas campestris* pv. *vignicola*) was encountered in all the districts (except Tororo and Pallisa) but the incidence was highest in Kumi. Viral and fungal diseases were prevalent in all the survey sites. Viral diseases were wide spread in both seasons, and were more severe in the intercropped than sole cropped cowpea. In contrast, scab, rust and powdery mildew were less common and less severe when cowpea was grown in intercrops (Table 10). The influence of intercropping in reducing disease and pest incidence has been reported (Mukiibi, 1976; Kato *et al.*, 1980; Keswani and Mreta, 1980; van Rheenen *et al*., 1981), a factor possibly contributing to the widespread use of intercropping in subsistence farming. In this study, disease data on inter-cropping are pooled from different crop combinations. Therefore, the effects of specific cropping combinations (systems; spatial arrangement) on disease occurrence are not known, and require investigation. Moreover, different pathogens behave differently under different crop combinations (Moreno, 1979).

Table 10. Percentage of farmers applying insecticides in different districts of Uganda, first rains 1994

Insecticide	Soroti	Kumi	Pallisa	Arua
		Percent of farmers		
Salut	26	73	63	0
Decis	26	20	29	0
Ambush CY (Cypermethrin)	20	7	4	100
Rogor (Dimethoate)	13	0	0	0
Karate	13	0	0	0
Perfekthion (Dimethoate)	0	7	0	0
% of fields sprayed	50	75	80	20

Higher incidence and severity of viral diseases, anthracnose (*Colleto-trichum lindemuthianum* (Sacc. and Magn. Bri. and Cav.) and scab were recorded during the first (wetter) than the second (drier) season (Table 11). The higher incidence and severity of the fungal diseases was expected as most fungal disease epidemics are favoured by humid conditions (Williams, 1975), although Iceduna *et al*. (1994) observed higher scab levels during the drier than wetter seasons. Higher viral infection was expected during the drier second rains when aphid levels were higher but viral attacks were higher during the first season.

Table 11. Influence of two cropping systems practiced in the major cowpea growing areas of Uganda on the severity (%) of different diseases of cowpea during the first and second rainy seasons of 1994[a]

Disease	Cropping system[b]			
	Intercrop	Sole crop	Mean	Significance[c]
	First rainy season			
Viral	14.90	11.90	13.40	*
Cercospora leaf spot	7.10	5.20	6.20	*
Anthracnose	0.00	5.40	2.70	*
Scab	0.00	3.20	1.60	*
False rust	0.04	0.00	0.02	NS
Dactuliophora leaf spot	0.20	0.60	0.40	NS
Powdery mildew	0.03	0.40	0.20	NS
	Second rainy season			
Viral	7.7	3.1	5.4	*
Cercospora leaf spot	4.5	4.2	4.3	NS
Scab	0.0	1.8	1.0	*
False rust	0.0	1.0	0.5	NS
Dactuliophora leaf spot	1.0	1.1	1.1	NS
Powdery mildew	0.0	0.1	0.04	NS
Rust	0.1	7.8	3.9	*

[a]Severity is % plant area affected (PAA)
[b]Mean of 10 plants per field in 90 and 110 fields during the first and second rains, respectively
[c] * Sign. at P=0.05; NS = not significant

Slightly higher incidence and severity of anthracnose and scab were associated with higher plant populations (data not presented) while slightly higher severity of viral diseases were associated with lower cowpea populations. Higher plant populations are known to reduce aphid infestation (Ogenga-Latigo *et al*., 1992a) and it is probable that the low incidence of viral disease(s) under high plant population was due to the unfavourable microclimate created for the aphids in the intercrops (Ogenga-Latigo *et al*., 1992a, b).

In general, higher incidence of anthracnose, scab and powdery mildew (*Erysiphe polygoni* De Candolle) were observed on the cultivar *Ebelat*, while higher incidence of Dactuliophora leaf spot (*Dactuliophora tarri* Leakey) occurred on the cultivar *Icirikukwai* (data not presented). In contrast, viral diseases were significantly more severe on cultivars *Amul* , *Osunyiri* and *Apee* in the second rains, but Cercospora leaf spots (*Cercospora canescens* Ell. and Mart. and *Cercospora cruenta*) were significantly more severe on cultivars *Osunyiri* and *Icirikukwai*, and in the second rains on *Amul*, *Osunyiri* and *Kisyanka*. The differences in "resistance" of these cultivars to the various diseases encountered may have contributed to variation in disease prevalence. It should be noted, however, that the disease levels on the different cultivars were not observed under the same environmental condition, or cropping system. These cultivars should, therefore, be screened under uniform and conducive conditions to confirm their resistance to the diseases in question.

Conclusions and Recommendations

Cowpea is an important food and potentially an important cash crop in eastern and northern Uganda. However, it has many pests, it is difficult to store, and thus, is perceived as a high risk crop, perhaps, accounting for the low hectarage planted. The development of effective pest management strategies is thus considered an important goal if cowpea production is to be sustained and expanded.

Our results suggest that the most important pests of cowpea in Uganda include, *Aphis craccivora*, *Megalurothrips sjostedti*, *Maruca vitrata*, pod sucking bugs (particularly *Clavigralla* sp.), and bruchids. However, their significance varies from region to region, and season to season, and might be related to the cropping systems, cultivars grown and weather fluctuations. Although the losses caused by insect pests were not estimated, preliminary findings revealed that they are significant (Sabiti *et al*., 1994; Omongo *et al.*, 1995; Omongo, 1996) and, therefore, require intervention. It is envisaged that future studies would examine economic thresholds of the economically important pests.

Future research should also analyse socio-economic factors that affect cowpea farmers' production goals and practices and their reciprocal impact on adoption of alternate pest management strategies. Initial evidence from a Rapid Participatory Assessment conducted in Kumi district in 1995 indicated that farmers producing cowpea largely for domestic consumption used different cultural practices, including pest management strategies, from those producing for markets (Erbaugh *et al.*, 1995). Verification of the relationship among production goals, cultural and current pest management practices should, therefore, be explored to provide the contextual knowledge base for developing alternative pest management interventions. Some of these issues have been addressed in recent studies (Isubikalu, 1998; Isubikalu *et al*., 1999).

It is also necessary to study the effect of different cultural control practices on the population dynamics of major cowpea insect pests, their predators and damage to cowpeas. Although the use, by some farmers, of calendar sprays indicates a possible important intervention point for the development of pest management alternatives, evidence obtained so far shows low returns to pesticide applications partly because of their improper use. If pesticides are to be used, there is need to determine the most appropriate time and frequency of insecticide application in the control of cowpea pests, and to integrate these with cultural control (see Karungi *et al*., 2000a, b).

Biological control is an important component of IPM, but little is known about the beneficial fora (insect predators and pollinators) on cowpea in Uganda. Occurrence of insect pest predators of cowpea in major cowpea agroecologies should be investigated in future studies. As a follow-up to this study, a species profile of insect pest predators of cowpea in major cowpea agroecologies has been compiled (Nampala *et al*., 1999a) but their relative contributions to cowpea pest control are still not known. Studies of storage technologies to reduce bruchid infestation have also been initiated.

Finally, there is need to increase the germplasm base and identify cultivars for the major cropping systems. In eastern Uganda, there is a need to select for market and home consumption: both spreading and non-spreading cultivars are required. For market, cowpea seed size and oil content appear important variables to consider. In the case of northern Uganda (West Nile) emphasis should be to identify high yielding and spreading cultivars for the cowpea+cassava and cowpea + sorghum cropping systems.

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