Influence of Season and Cropping System on Occurrence of Cowpea Diseases in Uganda

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ABSTRACT

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An on-farm survey was conducted for two seasons (first and second rains of 1994) to determine influence of season and cropping systems on occurrence of cowpea (*Vigna unguiculata*) diseases in Uganda. Viral diseases were widespread in both seasons but were more severe in the intercropped than in the nonintercropped cowpea. In contrast, scab, rust, and powdery mildew were less common and less severe when cowpea was grown in intercropped. High plant populations favored scab and anthracnose, but viral diseases were more severe under low plant populations. Higher incidence and severity of viral diseases, anthracnose, and scab were recorded during the first (wetter) season than during the second (drier) season. Disease level varied considerably among the common cultivars, but these differences may have been influenced by environmental differences.

In Uganda, cowpea (*Vigna unguiculata* (L.) Walp.) is traditionally grown by smallholder farmers whose farm holdings average 1 to 7 ha per family, of which 0.05 to 0.76 ha is cropped with cowpea (2,13). Most of the crop is grown during the shorter rainy season (August to October) and mostly monocropped. Recently, there has also been increased cultivation of the crop during the longer rainy season (March to June), largely in response to the high market demand for the crop (13).

Cowpea is often grown in mixed stands with sorghum (*Sorghum bicolor* (L.) Moench), greengram (*Vigna aureus* L.), maize (*Zea mays* L.), pigeonpea (*Cajanus cajan* (L.) Millsp.), and cassava (*Manihot esculenta* Crantz) (13). Although there is a wealth of literature on the effect of intercropping on legume pests and yield (9,12,15), literature is largely lacking on diseases, especially under farmer conditions. The most common diseases of cowpea in Uganda include cowpea aphid-borne mosaic (caused by the cowpea aphid-borne mosaic potyvirus), bacterial blight (*Xanthomonas vignicola* and *Pseudomonas syringae*), rust (*Uromyces phaseoli* (Pers.)

Wint.), zonate leaf spot (*Ascochyta phaseolorum* Sacc.), white zonate leaf spot (*Dactuliophora tarri* Leakey), false rust (*Synchytrium dolichi* (Cooke) Gaum), anthracnose (*Colletotrichum lindemuthianum* (Sacc. & Magnus) Bri. & Car.), scab (*Sphaeloma* sp.), gray leaf mold (*Cercospora canescens* Ellis & G. Martin), foot rot (*Fusarium solani* (Mart.) Sacc.), pod mold (*Cladosporium vignae* M.W. Gardner), Phyllosticta leaf spot (*Phyllosticta phaseolina* Sacc.), powdery mildew (*Erysiphe polygoni* DC.), and Fusarium wilt (*Fusarium oxysporum* f. sp. *tracheiphilum* (E.F. Sm.) W.C. Snyder & H.N. Hans.) (3).

The objectives of this study were to determine the seasonal occurrence of cowpea diseases and to examine the effect of cropping systems on the incidence and severity of diseases in farmers' fields.

MATERIALS AND METHODS

Site selection. Five districts were visited during the first rainy season of 1994 (March to June) and during the second rainy season (September to November) of the same year. These districts were selected because they are the major cowpea growing areas of Uganda (13) and they varied in agroecologies (Table 1). Data were collected from a sample of 10 farmers per county drawn from one county each of Arua, Lira, Tororo, and Nebbi districts; two each of Kumi and Pallisa; and three of Soroti district. In each county, the study area consisted of two parishes randomly chosen from a list of four to six parishes per county. A list of farmers was obtained for each parish, and 10 farmers were selected per county using random numbers.

Tororo and Lira districts were surveyed September to November, the traditional planting dates for these districts. Thus, a total of 90 fields was assessed during the first season and 110 during the second season.

Data collection and analysis. The severity and incidence of the major diseases affecting cowpea (3-5) were assessed on 10 plants chosen at random by walking in a zig zag manner, and spaced 10 m apart. Disease severity was rated using a modified scale of Horsfall and Barratt (6) with 0, 1, 5, 10, 25, 50, 75, and 100% of plant area affected (PAA), while disease incidence was the percentage of 10 plants showing symptoms. The cropping systems (mixed cropping versus monocropping) and cultivars grown were noted. Mean plant population was obtained by averaging the plant population in four quadrants (1 × 1 m).

Disease samples were taken to the Plant Pathology Laboratory at Makerere University for confirmation of symptoms and causal pathogens. For viral symptoms, serological tests were carried out at the cassava section of the Namulonge Agricultural and Animal Production Research Institute, Uganda. This was done only for the cowpea aphid-borne mosaic potyvirus (CAMV) and cucumber mosaic cucumovirus (CMV). Data analyses were conducted using the MSTAT-C computer package (Russel D. Freed, Michigan State University, East Lansing). Analysis of variance (ANOVA) was used to test variation of disease levels with season and cropping system. Where the *F* statistics were significant, means were separated using the Least Significant Difference (LSD) test at 5% probability level. Severity and incidence of different diseases were also related to plant population by correlation analysis (14).

RESULTS AND DISCUSSION

Higher incidence and severity of viral diseases (caused by CAMV and CMV), anthracnose, and scab were recorded during the first (wetter) season than during the second (drier) season (Table 2). This was expected, as most fungal disease epidemics are favored by humid conditions (16). For viral diseases, we expected higher infection during the drier second rains than during the long and wetter first rains because of the close relationship between

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aphid and viral incidences. However, aphid infestation was higher in the first rather than the second rains, and viral disease incidence was greater during the first season. We suspect that this was due to the short dry spells that occurred during the first season.

The present data and others (5) suggest a higher level of scab during the wetter (first) rains than the drier (second) rains. However, experiments over the past 2 years at Kabanyolo, Uganda, documented the contrary (7). In the case of false rust, the pathogen *Synchytrium dolichii* is an obligate parasite and may have been able to build up to higher levels during the second rains. In a previous study conducted at Kabanyolo, although the first rain crop had

low incidence of false rust, the second rain crop was devastated by the disease (4). Common rust (*U. phaseoli*) was not encountered during the first rains but was common during the second rains (Table 2). The fact that disease incidence and severity varied from season to season is indicative of the role rainfall, temperature, humidity, and inoculum level play in determining disease occurrence.

Except for viral diseases and *Cercospora* (*Cercospora canescens* and *C. cruenta*) and *Dactuliophora* leaf spots (*Dactuliophora tarri*), disease incidence and severities were generally lower in intercropped than in sole cropped fields (Tables 3 and 4). The influence of intercropping in reducing disease and pest incidence has been

reported (8,9,11,15), a factor probably contributing to the widespread use of intercropping in subsistence farming. Under natural farming conditions, i.e., without pesticide control, low disease probably occurred because of the ecological balance between host, pest, and environment (9). In this study, disease data on intercropping 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 (10).

Slightly higher incidence and severity of anthracnose and scab were associated with

Table 1. Location, temperature, mean annual rainfalls, altitudes, and cropping systems of the areas visited during the survey^a

Area of survey	Grid reference	Temperature (°C) (daily min-max)	Mean annual rainfall (mm)	Mean altitude (m)	Crops grown with cowpea
Arua ^b (Okollo) ^c	31° 1'E, 2° 7'N	20.0 - 35.0	875	610 - 742	Greengram, sorghum, cassava
Nebbi ^b (Pakwach) ^c	31° 3'E, 2° 4'N	22.5 - 35.0	875	610 - 742	Cassava, sorghum
Kumi ^b (Bukedea & Kumi) ^c	33° 7'E, 1° 5'N	17.5 - 27.5	1,000	914 - 1,066	Maize, cassava, sorghum
Soroti ^b (Soroti, Amuria & Usuk) ^c	33° 6'E, 1° 8'N	17.5 - 27.5	1,000	762 - 1,066	Greengram, cassava, sorghum
Pallisa ^b (Butebo & Pallisa) ^c	33° 6'E, 1° 1'N	17.5 - 27.5	1,250	914 - 1,066	Maize, cassava
Tororo ^d (Bunyole) ^c	33° 0'E, 0° 10'N	15.0 - 27.5	1,250	1,066 - 1,219	Cassava
Lira ^d (Erute) ^c	32° 9'E, 2° 6'N	15.0 - 33.0	1,000	914 - 1,066	Greengram, pigeonpea, cassava

^a Source: Atlas of Uganda, 1968. Department of Lands and Surveys, Entebbe, Uganda.

^b District.

^c County.

^d Not visited in the first rains.

Table 2. Incidence (% ± SE) and severity (% ± SE) of different diseases observed during the two rainy seasons of 1994 in Uganda^a

Disease	Season		Mean
	First rains ^b (March-May)	Second rains ^c (Sept.-Dec.)	
Incidence			
Viral	71.8 ± 2.6	40.5 ± 2.4	56.1
Cercospora leaf spot	29.9 ± 2.8	39.6 ± 3.8	34.7
Anthracnose	5.3 ± 2.0	0.1 ± 0.7	2.7
Scab	8.6 ± 1.5	4.6 ± 1.0	6.6
False rust	0.8 ± 0.1	5.8 ± 1.1	8.3
Dactuliophora leaf spot	6.3 ± 1.4	7.1 ± 1.4	6.7
Powdery mildew	1.1 ± 0.6	1.2 ± 0.3	1.1
Rust	0.0 ± 0.0	2.2 ± 0.8	1.1
Severity			
Viral	12.5 ± 0.9	5.4 ± 0.5	8.9
Cercospora leaf spot	7.0 ± 1.0	5.2 ± 0.5	6.1
Anthracnose	2.2 ± 0.7	0.5 ± 0.2	1.4
Scab	1.5 ± 0.3	0.7 ± 0.2	1.1
False rust	1.4 ± 0.0	1.0 ± 0.2	1.2
Dactuliophora leaf spot	0.3 ± 0.1	0.5 ± 0.2	0.4
Powdery mildew	0.2 ± 0.1	0.2 ± 0.1	0.2
Rust	0.0 ± 0.0	2.3 ± 1.4	1.2

^a Severity is percent plant area affected; disease incidence is the percentage of 10 plants showing symptoms.

^b Mean of 90 fields.

^c Mean of 110 fields.

Table 3. Influence of two cropping systems practiced in the major cowpea growing areas of Uganda on the incidence (%) and severity (%) of different diseases of cowpea during the first rainy season of 1994^a

Disease	Cropping system ^b		Mean
	Intercrop	Monocrop	
Incidence			
Viral	76.7	72.2	74.4
Cercospora leaf spot	29.5	27.7	28.6
Anthracnose	0.0	23.6	11.8
Scab	0.0	18.4	9.2
False rust	0.2	0.0	0.1
Dactuliophora leaf spot	1.2	4.9	3.0
Powdery mildew	0.3	2.3	1.3
Severity			
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
Dactuliophora leaf spot	0.20	0.60	0.40
Powdery mildew	0.03	0.40	0.20

^a Severity is percent plant area affected; disease incidence is the percentage of 10 plants showing symptoms.

^b Mean of 10 plants per field in 20 fields for severity; mean of 20 fields for incidence.

higher plant populations (Table 5). In contrast, slightly higher severity of viral diseases was associated with low cowpea populations. Plant population is known to modify microclimate under field conditions (1). It is probable that the high incidence and severity of scab and anthracnose were due to a relatively humid microclimate, which favors epidemics of these diseases (16). Higher plant populations are also known to reduce aphid infestation (12). Some of the virus diseases of cowpea, such as CAMV and CMV, are transmitted by aphids. It is probable that the low viral disease incidence under high plant population was due to the unfavorable microclimate created for the aphids in the intercrops (12).

During the first rains, significantly higher incidences of anthracnose ($P = 0.006$), scab ($P = 0.001$), and powdery mildew ($P = 0.05$) were observed on the cultivar Ebelat, while higher incidence of *Dactuliophora* leaf spot ($P = 0.001$) occurred on the cultivar Icirikukwai (Tables 6 and 7). In contrast, during both rainy seasons, viral diseases were significantly ($P = 0.001$) more severe on cultivars Amul and Osu (and Apei in the second rains), but *Cercospora* leaf spot was significantly ($P = 0.001$) more severe on cultivars Osu and Icirikukwai, and in the second rains on Amul, Osu, and Kisyanka. The differences in resistance of these cultivars to the various diseases encountered may have contributed to variation in disease prevalence.

In most districts, farmers chose the varieties they grew based on aspects such as taste and early maturity. For example, in Pallisa district, farmers preferred the cultivar Ebelat, which has good market in the district. Thus, the disease levels on the various cultivars were not observed under the same environmental conditions or cropping system. These cultivars should, therefore, be screened under uniform and disease conducive conditions to confirm resistance.

The present study provides a general picture of occurrence of cowpea diseases in Uganda. More detailed investigations are needed to isolate effects of crop combinations. Information is also needed on the effect of plant densities and spatial ar-

Table 4. Influence of two cropping systems practiced in the major cowpea growing areas of Uganda on the incidence (%) and severity (%) of different diseases of cowpea during the second rainy season of 1994^a

Disease	Cropping system ^b		
	Intercrop	Monocrop	Mean
Incidence			
Viral	48.5	32.3	40.4
<i>Cercospora</i> leaf spot	47.8	32.5	40.2
Scab	0.0	13.4	6.7
False rust	0.2	5.8	3.0
<i>Dactuliophora</i> leaf spot	14.8	9.5	12.2
Powdery mildew	0.0	0.8	0.4
Rust	0.8	7.0	3.9
Severity			
Viral	7.7	3.1	5.4
<i>Cercospora</i> leaf spot	4.5	4.2	4.3
Scab	0.0	1.8	1.0
False rust	0.0	1.0	0.5
<i>Dactuliophora</i> leaf spot	1.0	1.1	1.1
Powdery mildew	0.0	0.1	0.04
Rust	0.1	7.8	3.9

^a Severity is percent plant area affected; disease incidence is the percentage of 10 plants showing symptoms.

^b Mean of 10 plants per field in 20 fields for severity; mean of 20 fields for incidence.

Table 5. Correlation coefficients among disease incidence, severity, and plant population (number of plants m⁻²)

Disease	Incidence × P1 ^a	Severity × P1	Incidence × P2	Severity × P2
First rains (March-May)				
Viral	-0.15	0.11	-0.01	-0.39** ^b
<i>Cercospora</i> leaf spot	—	—	-0.07	-0.09
Anthracnose	—	—	0.40**	0.40**
Scab	—	—	0.51**	0.47**
False rust	—	—	NS	NS
<i>Dactuliophora</i> leaf spot	—	—	0.28*	0.27*
Powdery mildew	—	—	NS	NS
Second rains (Sept.-Dec.)				
Viral	-0.03	-0.01	-0.29*	-0.31*
<i>Cercospora</i> leaf spot	—	—	0.01	0.25
Anthracnose	—	—	0.06	0.07
Scab	—	—	0.64***	0.62***
False rust	—	—	0.09	0.04
<i>Dactuliophora</i> leaf spot	—	—	-0.34**	-0.37**
Powdery mildew	—	—	NS	NS
Rust	—	—	NS	NS

^a P1 (7.4 to 20.4 plants m⁻² and 8.3 to 22.2 plants m⁻² during the first and second seasons, respectively) and P2 (3.5 to 13.3 plants m⁻² and 6.0 to 16.6 plants m⁻² during the first and second seasons, respectively) indicate plant population at early vegetation and maturity, respectively.

^b *, **, *** indicate levels of significance at $P = 0.05$, $P = 0.01$, and $P = 0.001$, respectively. Dashes = absence of fungal diseases during early vegetation. NS = not significant.

Table 6. Incidence (%) and severity (%) of different diseases on four commonly grown cowpea varieties in Uganda during the first season of 1994^a

Disease	Variety ^b				Mean
	Amul	Osu	Icirikukwai	Ebelat	
Incidence					
Viral	80.3	73.0	61.3	61.8	69.1
Cercospora leaf spot	17.7	41.3	35.1	33.3	31.9
Anthracnose	0.0	0.0	0.0	6.3	1.6
Scab	0.0	0.0	6.3	22.3	7.2
False rust	0.0	0.3	0.0	0.0	0.1
Dactuliophora leaf spot	0.7	1.7	19.3	6.7	7.1
Powdery mildew	0.0	0.7	0.0	4.7	1.3
Severity					
Viral	12.1	17.7	8.6	7.8	11.6
Cercospora leaf spot	2.0	12.3	10.2	4.9	7.3
Anthracnose	0.0	0.0	0.0	0.8	0.2
Scab	0.0	0.0	1.4	3.9	1.3
False rust	0.0	0.3	0.0	0.0	0.1
Dactuliophora leaf spot	0.3	0.1	0.1	0.8	0.3
Powdery mildew	0.0	0.1	0.0	0.7	0.2

^a Severity is percent plant area affected; disease incidence is the percentage of 10 plants showing symptoms.

^b Mean of 10 plants per field in 10 fields for severity; mean of 90 fields for incidence.

Table 7. Incidence (%) and severity (%) of different diseases on five commonly grown cowpea varieties in Uganda during the second season of 1994^a

Disease	Variety ^b					Mean
	Amul	Osu	Ebelat	Apei	Kisyanka	
Incidence						
Viral	51.3	45.7	35.5	47.3	29.0	41.8
Cercospora leaf spot	48.0	47.7	24.3	6.7	40.7	33.5
Scab	0.0	0.0	16.5	6.0	10.3	6.6
False rust	0.3	0.0	0.0	6.3	11.7	3.7
Dactulophora leaf spot	11.7	18.0	0.0	2.3	19.0	10.2
Powdery mildew	0.0	0.0	1.5	0.3	0.0	0.4
Rust	1.7	0.0	0.0	0.0	14.0	3.1
Severity						
Viral	7.9	7.5	4.0	6.9	2.2	7.7
Cercospora leaf spot	3.8	5.3	4.9	0.3	3.4	3.5
Scab	0.0	0.0	2.1	1.0	1.6	0.9
False rust	0.0	0.0	0.0	1.3	2.0	0.7
Dactulophora leaf spot	0.4	2.0	0.0	0.1	2.3	1.0
Powdery mildew	0.0	0.0	0.1	0.1	0.0	0.1
Rust	0.2	0.0	0.0	0.0	0.0	15.5

^a Severity is percent plant area affected; disease incidence is the percentage of 10 plants showing symptoms.

^b Mean of 10 plants per field in 10 fields for severity; mean of 110 fields for incidence.

rangements on the different diseases. A clear understanding of the epidemiology of these diseases is critical in the development of an effective disease management package.

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