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EVALUATION OF 80 COWPEA LINES FOR RESISTANCE TO SCAB, *SPHACELOMA* SP

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ABSTRACT

Eighty cowpea lines were evaluated in Uganda under natural disease pressure for resistance to *Sphaceloma* sp., the causal agent of cowpea scab, during the second (short) rains of 1991 and the first (long) and second rains of 1992. Scab severity (percent plant area affected) varied with season and averaged 32% in 1991, and 2% and 24% during the first and second rains of 1992, respectively. Cowpea lines were ranked as resistant, moderately resistant, and susceptible when percent plant area affected averaged <15, 15–30, and >30 in 1991; <1.5, 1.5–4.0, >4.0 in the first rains of 1992; and <15, 15–24, and >24 in the second rains of 1992. Overall, 25 lines were considered resistant, 20 moderately resistant and 35 susceptible.

***Key Words*: AUDPC, disease rating, resistance, screening, *Vigna unguiculata*.**

RÉSUMÉ

Quatre-vingt lignées de niébé exposées à l'infection naturelle ont été évaluées en Uganda pour résistance à *Sphaceloma* sp, l'agent causal de la gale du niébé, pendant les secondes (courtes) pluies en 1991 et les premières (longues) et les secondes pluies en 1992. La gravité de la gale (pourcentage de la surface de plante affecteé) variait avec la saison avec une moyeunne de 32% en 1991 et de 2 et 24% pendant les premières et les secondes pluies de 1992 respectivement. Les ligneés de niébé ont été classées en résistantes, modérément résistantes et susceptibles selon que le pourcentage moyen de la surface de plante affectée était <15, 15-30 et > 30 en 1991; <1,5; 1,5 - 4,0; >4,0 pendant les première pluies de 1992 et <15-24, et > 24 pendant les secondes pluies de, 1992. Dans l'ensemble 25 lignées ont été considereés comme résistantes, 20 comme modérement résistantes et 35 comme susceptibles.

***Mot Clés*: AUDPC, évaluation d'infection, résistance, sélection, *Vigna unquiculata*.**

INTRODUCTION

Scab, caused by the fungus *Sphaceloma sp.*, is one of the most destructive diseases of cowpea (*Vigna unguiculata* L. Walp) in tropical Africa (Allen, 1983). It is a seed-borne disease which affects all the above ground parts of the plant — leaves, petioles, stems, and pods (Emechebe, 1980; Allen, 1983). Lesions on stems often coalesce and cover the entire stem while those on leaves always result in shot holes (Emechebe, 1980). Severe infections cause flower bud abortion and reduced podding, and malformation of pods with almost no seed set. Yield losses of up to 60–100% have

been reported from Nigeria (Emechebe, 1980) and Zambia (Kannaiyan *et al.*, 1987).

Control measures recommended against scab are crop rotation, sanitation, fungicidal seed treatment and spraying, and host plant resistance. Use of host plant resistance is the most economical as, besides the resistant seeds needed no other inputs are required by the farmer (IITA, 1982). Screening cowpea lines for resistance to scab has, however, met with only limited success. In trials conducted in Zambia, none of the 210 cowpea lines screened for resistance to various diseases showed high resistance to scab, and only five were moderately resistant (Kannaiyan *et al.*, 1987). Similarly, in trials conducted in 1988-1989 in Kabanyolo, Uganda, most of the 200 cowpea lines tested were moderately resistant or susceptible to scab (Takan, 1988).

Due to the important need to develop cowpea lines resistant to scab, further screening of cowpea accessions for possible sources of resistance to scab was carried out among recent cowpea collections made from within and outside Uganda.

MATERIALS AND METHODS

The screening was carried out at Makerere University Agricultural Research Institute, Kabanyolo (MUARIK) during the second (short) rains of 1991 and the first (long) and second rains of 1992. Kabanyolo is located about 17 km north of Kampala, and lies at latitude 0°28'N, longitude 32°37'E, and an altitude of 1204 m above sea level. The climatic data for the study period are presented in Figure 1.

Experimental design. Eighty cowpea lines were used in this study, of which 30 were from IITA, 20 from Uganda, and 30 from Kenya and Tanzania. The cowpea lines were provided by the Makerere University Grain Legume Improvement Programme. The study was conducted under natural field infections.

Land used for the experiments was previously under pigeonpea (*Cajanus cajan* (L.) Millsp.) for the second rains of 1991, soybean (*Glycine max* L.) for the first rains of 1992, and cowpea for the second rains of 1992. The cowpea lines were planted out in single rows of 4 m length in 1991 and 3 m in 1992. The spacing was 60 cm between rows and 30 cm within the row. The experiment was arranged in a Randomised Complete Block Design (RCBD), with three replications in the second rains of 1991 and four replications in the first and second rains of 1992. Blocks were bordered by three and two rows of a susceptible line, IT83S-872, in 1991 and 1992, respectively. Planting dates were 30 September 1991, and 29 March and 27 September 1992. Two seeds were sown in each hole and the seedlings thinned to one plant per hill when about 15 cm high.

Plots were hand-weeded three times each season, and no fertilizers were applied. Insecticides were applied only in the second rains of 1991 to control heavy infestation of the crop by aphids and other insect pests. Ambush CY EC (50 g cypermethrin l^{-1}) was applied on 25 October while Rogor EC (dimethoate, 400 g a.i. l^{-1}) was applied on 30 November at the recommended rates.

Data collection and analyses. Six to seven weeks after crop emergence, five plants in each row were randomly selected, tagged and used for disease assessment. Disease severity was visually rated using a modified Horsfall-Barret scale (Campbell and Madden, 1990) of 0, 1, 5, 10, 25, 50, and 75% of plant area affected. This was done 59, 66, 73, 80, 88, and 95 days after planting (DAP) in 1991; 53, 59, 63, 84, and 91 DAP during the first rains of 1992; and 55, 76, and 87 DAP during the second rains of 1992.

Data analyses were conducted using the MSTAT-C Statistical package (Russell D. Freed, Michigan State University, U.S.A.). Disease increase over time was plotted for each genotype. Area under disease progress curve (AUDPC) was computed as described by Campbell and Madden (1990). Slopes (r) and the intercepts (y_o) of the linearised regression equations describing increase of disease severity over time were computed using the exponential model (Campbell and Madden, 1990). However, because of the low disease level during the first rains and the few assessment times during the second rains, r values were not calculated for the 1992 plantings. Analysis of variance (ANOVA) was conducted using the one factor Randomised Complete Block Design. Correlations between the different disease assessment days and AUDPC were also calculated.

RESULTS

Rainfall during the crop growth period totalled 283.1, 507.0 and 442.5 mm for the second rains of

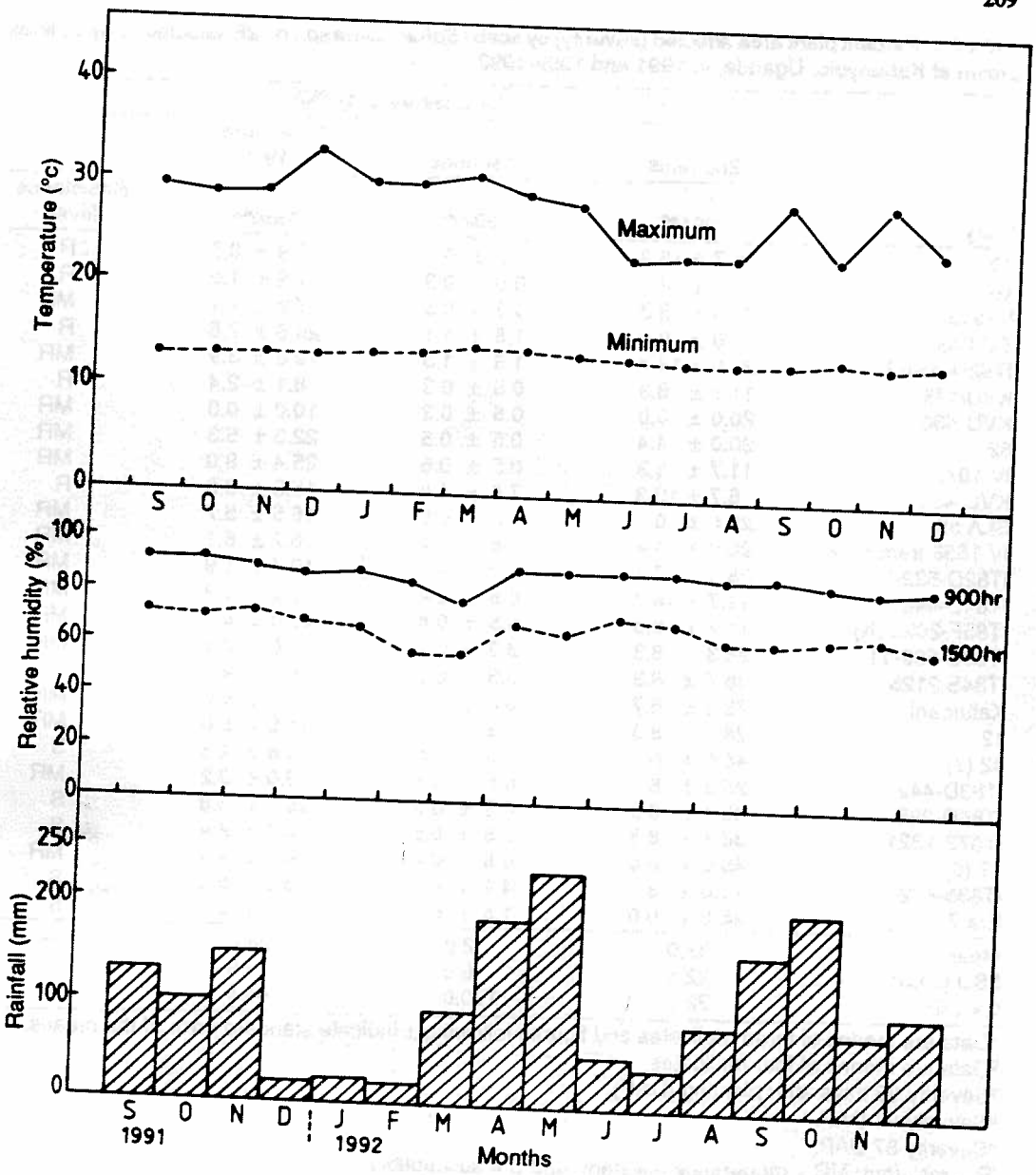

Figure 1. Rainfall (mm), relative humidity (%), and temperature (°C) over the study period: September 1991–December 1992.

1991, first rains of 1992 and second rains of 1992, respectively (Fig. 1). The highest incidence and severity of scab was recorded during the second rains of 1991 (Table 1) and all the cowpea lines evaluated were infected by the disease. By 63 DAP, only 12 lines, IT87S-1390, MRS 23, ex Wekomire, IT82D-522-1, IT81D-994 (K), KVU-454, IT82D-716, 91b, IT87S-1459, IT87S-1393, Majije 4, and IT85D-3577 had symptoms of scab. IT85S-818 and IT85F-2269 developed scab symptoms only after 84 DAP. These two lines were not infected throughout the first rainy season of 1992.

Leaf lesions had silvery spots with halos and, in lines such as IT83S-872, leaves were distinctly cupped and had more than 204 lesions each. Pods, stems, and petioles were most affected, silvery grey circular to oval lesions being distinct on

TABLE 1. Percent plant area affected (severity) by scab (*Sphaceloma* sp.) on 26 selected cowpea lines grown at Kabanyolo, Uganda, in 1991 and 1992/1993

	Disease severity (%)			
	2nd rains	1st rains	2nd rains 1992	
Entry	1991[ac]	1992[bd]	1992[be]	Resistance level[f]
39	6.7 ± 13.3	0.5 ± 0.3	3.9 ± 0.7	R
46	11.7 ± 8.3	0.5 ± 0.3	4.9 ± 1.0	R
N1593	28.3 ± 8.3	0.3 ± 0.5	7.2 ± 1.1	MR
TVU-465	1.0 ± 0.0	1.8 ± 1.1	20.6 ± 7.6	R
IT82D-634-2	20.0 ± 14.4	1.8 ± 1.3	19.6 ± 3.9	MR
KVU/175	11.7 ± 8.3	0.5 ± 0.3	8.1 ± 2.4	R
KVU-530	20.0 ± 0.0	0.5 ± 0.3	10.0 ± 0.0	MR
82	20.0 ± 14.4	0.5 ± 0.5	22.3 ± 5.3	MR
IV 1075	11.7 ± 8.3	0.5 ± 0.6	25.4 ± 9.0	MR
KVU-454	6.7 ± 13.3	7.5 ± 4.8	15.3 ± 3.6	R
SLA 59	20.0 ± 0.0	1.8 ± 0.9	16.5 ± 5.7	MR
IV 1658 Iram Prak	20.0 ± 14.4	3.8 ± 2.4	16.7 ± 6.1	MR
IT82D-522-1	28.3 ± 7.2	4.0 ± 1.0	19.4 ± 1.9	MR
IT84D-448	11.7 ± 16.7	0.8 ± 0.4	19.6 ± 1.3	MR
IT85F-2020 (K)	11.7 ± 8.3	0.5 ± 0.6	20.3 ± 8.0	MR
IT83S-689-11	28.3 ± 8.3	3.3 ± 2.1	21.0 ± 2.3	MR
IT84S 2125	36.7 ± 8.3	0.3 ± 0.5	16.9 ± 4.7	S
Katumani	28.3 ± 16.7	0.3 ± 0.5	13.8 ± 9.0	MR
12	28.3 ± 8.3	0.3 ± 0.5	11.5 ± 5.0	MR
42 (7)	45.0 ± 0.0	0.5 ± 0.5	13.8 ± 4.3	S
IT83D-442	28.3 ± 8.3	0.5 ± 0.1	19.0 ± 3.2	MR
IT85D-3850-2	36.7 ± 8.3	0.5 ± 0.5	15.3 ± 3.8	S
IT87S 1321	36.7 ± 8.3	0.8 ± 0.5	18.1 ± 2.4	S
17 (6)	45.0 ± 0.0	0.8 ± 0.4	14.1 ± 4.1	MR
IT835-872	75.0 ± 3.1	4.4 ± 4.0	33.9 ± 5.8	S
Era 7	45.0 ± 0.0	1.5 ± 0.5	16.3 ± 0.6	S
Mean	32.0	2.0	24.0	–
LSD (0.05)	22.1	6.0	14.8	–
CV (%)	22.1	170.0	44.4	–

[a]Data are means of three replicates and figures following ± indicate standard error of the means.
[b]Data are means of four replicates.
[c]Severity 95 days after planting (DAP).
[d]Severity 91 DAP.
[e]Severity 87 DAP.
[f]R = resistant; MR = moderately resistant; and S = susceptible.

many IITA lines. In 1991, 29 lines had more than 45% mean plant area affected, and were rated very susceptible, 11 with 30–44% were rated susceptible, 19 lines with 15–29% were rated moderately resistant, while the 21 lines with less than 15% plant area affected were rated resistant.

In 1992, severity of the disease was much higher during the second rains (mean 24%) than during the first rains (mean 2.1%) (Tables 1 and 2; Fig. 2). Disease severity ranged from 3.9 to 50.8% during the second rains of 1992, which was comparable to disease level obtained during the second rains of 1991 (6.7–75.0%).

Resistant accessions tended to develop the disease late in the two short rainy seasons and the disease level for the accessions remained low, hence the low AUDPC (Fig. 2). For example, during the second rains of 1992, lines 39 and 46 had no scab symptoms up to 73 DAP; these two lines had the lowest AUDPC of 15.7 and 16.5, respectively. In contrast, by 73 DAP, susceptible lines such as IT83S-872 had more than 50% plant

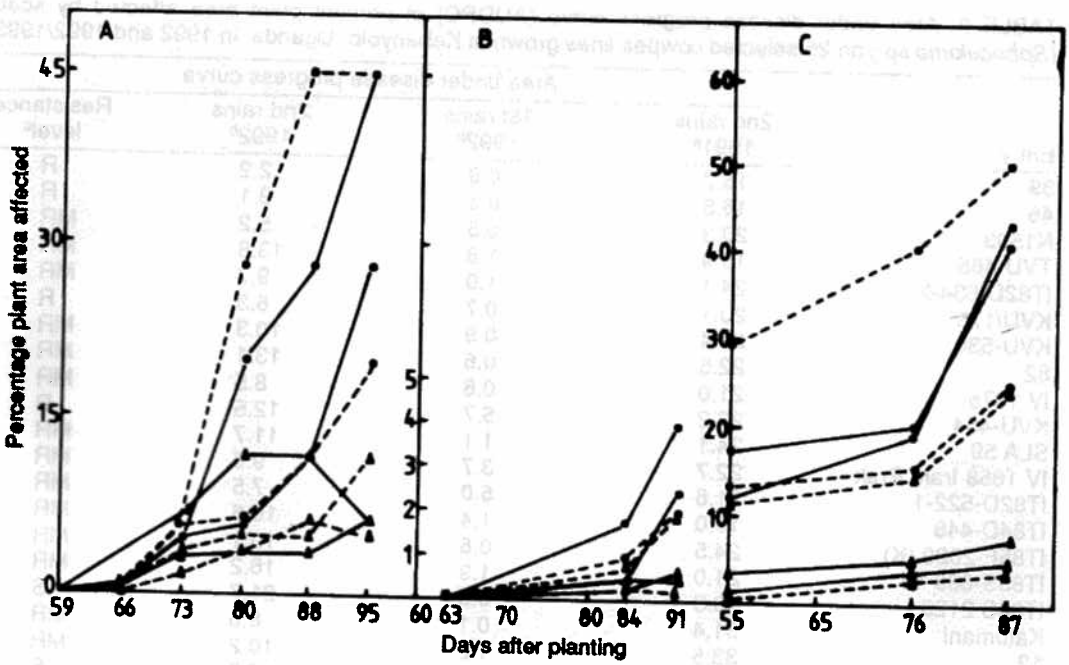

Figure 2. Disease progress curves of scab, caused by *Sphaceloma* sp. on some cowpea lines grown at Kabanyolo, Uganda, during the second rains of 1991 (A), first rains of 1992 (B), and second rains of 1992 (C).

area affected while resistant lines had less than 15%. The resistant lines had fewer lesions which were not as distinct as those found on the susceptible lines. Only tiny spots formed on pods of resistant lines.

When AUDPC's were calculated from the different assessment data in 1991, the values ranged from 15.7 for the resistant genotype (39) to more than 40.0 for the susceptible lines (IT835-872, 42 (7), and IT84S 2125) (Table 2). Accessions with AUDPC less than 25 were rated resistant, 25-34 moderately resistant, and more than 34 were rated susceptible. The most resistant lines included 39, TVU 465, 46, IT84D-448, IT81D-994 (K), KVU/175, N1593, TVX 1948-01F, IV 1075, IT83S-689-11, KVU 530, IT82D-522-1, IT82E-12, 82, IV 1658 Iram Prak, KVU 454, SLA 59, and IT82D-634. AUDPC values were generally lower in 1992 due to the lower disease pressure.

Of the 25 lines considered resistant to scab in the three seasons, seven were resistant in all the three seasons (N1593, 39, KVU/175, 46, KVU-530, TVU-465, IT82D-634-2); two in second rains of 1991 and first rains of 1992 (82, IV 1075); 14 in the second rains of 1991 and 1992 (39, 46, N1593, KVU/175, KVU-530, KVU-454, SLA 59, IV 1658 Iram Prak, IT82D-522-1, IT82D-634-2, IT84D-448, IT85F 2020 (K), TVU-465, IT83S-689-11) and 16 during the first and second rains of 1992 (N1593, IT84S-2125, KVU/175, Katumani 80, 12, 42(7), IT83D-442, KVU-530, 39, 46, IT85D-3850-2, IT87S-1393, 17, ERA-7, TVU-465, IT82D-634-2).

Although significant genotype differences were indicated by the apparent infection rates (Table 3), differences among genotypes were not as distinct as when AUDPC or percent leaf area affected were used. TVU-465 which was fairly resistant was among the highest yielders.

Correlation analysis indicated significant relationships between AUDPC and percentage severity assessed at 73 (0.88; P= 0.001), 80 (0.90; P= 0.001), 88 (0.91; P= 0.001) and 95 (0.83; P= 0.001) DAP for 1991. However, the relationship between AUDPC and the apparent infection rate

TABLE 2. Area under disease progress curve (AUDPC) of percent plant area affected by scab (*Sphaceloma* sp.) on 25 selected cowpea lines grown at Kabanyolo, Uganda, in 1992 and 1992/1993

Entry	Area under disease progress curve			
	2nd rains 1991[a]	1st rains 1992[b]	2nd rains 1992[b]	Resistance level[c]
39	15.7	0.9	2.2	R
46	16.5	0.6	3.1	R
N1593	20.3	0.5	5.2	MR
TVU-465	15.9	1.8	13.8	MR
IT82D-634-2	24.1	1.0	9.7	MR
KVU/175	20.1	0.7	6.3	R
KVU-530	21.4	0.9	10.3	MR
82	22.5	0.6	13.1	MR
IV 1075	21.0	0.6	8.5	MR
KVU-454	23.2	5.7	12.5	R
SLA 59	24.1	1.1	11.7	MR
IV 1658 Iram Prak	22.7	3.7	9.6	MR
IT82D-522-1	21.6	5.0	7.5	MR
IT84D-448	19.0	1.4	10.6	MR
IT85F-2020 (K)	24.5	0.6	10.1	MR
IT83S-689-11	21.0	1.9	16.2	MR
IT84S 2125	40.3	0.5	21.7	S
Katumani	31.4	0.1	8.0	MR
12	33.5	1.2	10.2	MR
42 (7)	45.0	1.4	27.3	S
IT83D-442	25.7	0.9	15.7	MR
IT85D-3850-2	31.9	0.6	17.9	S
IT87S 1321	35.9	0.9	19.3	S
17 (6)	34.0	0.7	9.3	MR
IT835-872	43.0	4.6	28.8	S
Era 7	29.6	1.3	8.3	MR
Mean	31.0	2.1	14.6	–
LSD (0.05)	12.0	6.3	11.1	–
CV (%)	24.1	115.0	47.2	–

[a]Data are means of three replicates.
[b]Data are means of four replicates
[c]R = resistant; MR = moderately resistant; and S = susceptible.

(r), though significant (-0.50; P= 0.01) was relatively low. In contrast, the relationships between yield and AUDPC were significant during the second rains of 1991 (0.66, P = 0.01) and 1992 (0.47, P=0.01).

DISCUSSION

The results confirm previous observations (Allen, 1983; Takan, 1988) that scab is a very devastating disease of cowpea in Uganda. Considerable variation in susceptibility to scab was recorded among the 80 cowpea lines tested, indicating varied level of resistance to *Sphaceloma*. All the 80 accessions were affected by scab and the majority of the cowpea accessions were rated susceptible. It was only during the first rains of 1992 that two cowpea lines (IT83S-818 and IT85F-2269) had no symptoms of scab throughout the trial. Both lines were, however, severely affected by bacterial blight and this could have interfered with the scab infection process.

There was considerable variation in disease levels between years and even seasons as reflected in Tables 1-3. Scab was more severe under conditions of lower than of higher rainfall. With rainfall totals of 283.1, 501, and 442 mm, scab severity averaged 32, 2, and 24% for the second rains of 1991, and first and second rains of 1992, respectively. These results are contrary to previous reports (Allen, 1983; Emechebe, 1980) which suggest that scab is more severe under wet conditions because conidia are supposedly dispersed by rainsplash. Additional studies, especially under controlled conditions, are therefore required to further characterise the

TABLE 3. Intercept (Y_o^*) and slope (r) of the linearized increase in percentage plant area affected by scab (caused by *Sphaceloma* sp.), and yield of 20 resistant and moderately resistant and one susceptible cowpea assessions tested at Kabanyolo, Uganda, 1991[a]

Entry	Y_o^*	r^{bc}	Grain yield (g)[d]
39	-100.5	0.289	164
TVU-465	-82.9	0.240	353
46	-102.3	0.298	187
IT84D-448	-85.5	0.248	169
IT81D-994 (K)	-79.2	0.231	191
KVU/175	-92.2	0.267	63
NI593	-90.8	0.263	83
TVX1948-01F	-79.2	0.232	87
IV 1075	-79.2	0.231	88
IT835-689-11	-88.1	0.256	124
KVU-530	-96.5	0.279	130
IT82D-522-1	-77.0	0.225	169
IT82D-12	-89.6	0.260	192
82/83	-95.1	0.275	131
IV 1658 Iram Prak	-75.4	0.220	253
KVU 454	-82.0	0.238	186
SLA 59	-89.1	0.259	101
IT82D-634-2	-76.9	0.225	194
84	-89.8	0.263	120
IT85F-2020 (K)	-74.4	0.218	136
IT835-872	-88.3	0.258	200
Mean	-79.6	0.234	132
LSD (0.05)	-6.6	0.017	11

[a]Data are means of three replicates.
[b]Disease severity was assessed 59, 66, 73, 80, 88, and 95 days after planting.
[c]Intercept and slope calculated using the linearized exponential model (Vanderplank, 1963; Campbell and Madden, 1990).
[d]Yield per 5 plants.

relationship of scab incidence with initial inoculum level, rainfall, temperature, and relative humidity. The high coefficient of variation during the first rains of 1992 is expected, since there was low disease incidence and only susceptible lines recorded appreciable disease levels. Variations in reactions of cowpea lines between the second rains of 1991 and 1992 further reflected the non-uniform scab infection, since lines were exposed only to natural disease pressure. Greater discrimination among the accessions could probably have been achieved under artificial inocula especially from infested residue.

The primary aim of this study was to screen for possible sources of cowpea resistance to scab. The start and frequency of disease assessment is important in economic terms as well as to establishing reliable disease—yield relationships. The results from this study suggest that the use of AUDPC and single late assessment are equally effective for identifying resistant germplasm. Since AUDPC requires multiple assessments, single assessment, at 95 DAP for example, would be cost effective. For many diseases, foliage senescence at this stage interferes with disease symptoms. This, however, is not the case with scab, especially in pods where lesions are clearly distinct even after maturity. Furthermore, some cowpea lines tended to develop scab later than others. Thus, earlier assessments would probably mis-represent the resistance status of the "late season" susceptible lines (Christ, 1991).

Emphasis on cowpea improvement in tropical Africa is focused on producing insect and disease resistant varieties, and on breeding agronomic suitable varieties (IITA, 1985). Lines in this study that have shown some degree of resistance to *Sphaceloma* could therefore be used in these improvement programmes.

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REFERENCES

Allen, D.J. 1983. *The Pathology of Tropical Food Legumes. 'Disease Resistance in Crop Improvement*. A Wiley - Interscience Publication, New York. 413 pp.

Campbell, C.L. and Madden, L.V. 1990. *Introduction to Plant Disease Epidemiology*. John Wiley and Sons, New York. 531 pp.

Christ, B.J. 1991. Effect of disease assessment method on ranking potato cultivars for resistance to early blight. *Plant Disease* 75: 353-356.

Emechebe, A.M. 1980. Scab disease of cowpea (*Vigna unguiculata*) caused by *Sphaceloma*, a species of the fungus. *Annals of Applied Biology* 96:11–16.

International Institute of Tropical Agriculture (IITA). 1982.*Cowpea Production Manual*. International Institute of Tropical Agriculture, Ibadan. Manual Series No. 11. 198 pp.

Kannaiyan, J., Greenberg, D.C., Haciwa, H.C. and Mbewe, M.N.1987. Screening cowpea for resistance to major diseases in Zambia. *Tropical Grain Legume Bulletin* 34: 23–26.

Takan, J.P. 1988. Field evaluation of cowpea (*Vigna unguiculata* L. Walp) cultivars for resistance to zonate leafspots (*Ascochyta phaseolorum* Sacc. and *Dactuliophora tarri* Leakey) and bacterial blights (*Xanthomonas vignicola* Burkholder and *Pseudomonas syringae* Van Hall). Special Project Report, Faculty of Agriculture and Forestry, Makerere University. 40 pp.

Vanderplank, J.E. 1963. *Plant Diseases: Epidemics and Control*. Academic Press, New York. 349 pp.