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Evaluation of 62 cowpea lines for resistance to false rust (*Synchytrium dolichi* (Cooke) Gaum) and scab (*Sphaceloma* sp.)

R. Edema, E. Adipala and D.A. Florini[†]
Department of Crop Science, Makerere University, P.O. Box 7062, Kampala, Uganda
[†]International Institute of Tropical Agriculture, Oyo Road, PMB 5320, Ibadan, Nigeria

Abstract

We evaluated 62 cowpea lines for field resistance to false rust (*Synchytrium dolichi*) and scab (*Sphaceloma* sp.). To increase disease pressure susceptible entries were grown two weeks prior to planting the test entries. The entries were grouped as resistant, moderate-resistant, moderately susceptible or susceptible on the basis of standardised Z-scores of areas under disease progress curves. In the case of scab, three entries, namely, TVU4630, *Ebelat* (local) and *Icirikukwai* (local) were rated resistant. Likewise, IT88D-643-1, IT90K-56 and IT90K-1026 were rated resistant to false rust but the majority of the local land races were susceptible to false rust.

Key words: Disease resistance, z-scores, *Vigna unguiculata*, Uganda

Introduction

Field screening of widely assembled germplasm has for a long time been used to evaluate different crops against many destructive diseases (Kwaje, 1975). As a result, cultivars with high levels of field resistance, that are non-specific to many pathogens of useful crops have been developed. Even a low level of resistance is important as it reduces the need to apply pesticides (Mathews, 1984). Since cowpea (*Vigna unguiculata* (L.) Walp) is a low value commodity, this approach is the cheapest pest management strategy for the crop.

In eastern Africa, cowpea is attacked by a wide range of diseases, but generally, the most destructive are false rust (*Synchytrium dolichi* (Cooke) (Guam), scab (*Sphaceloma* sp.), cowpea aphid-borne mosaic (caused by the cowpea aphid-borne mosaic potyvirus), Cercospora leaf spots (*Cercospora canescins* Ell. & Mart & *Cercospora cruenta*) and in some localities, white zonate leaf spot (*Dactuliophora tarri* Leakey) (Edema and Adipala, 1996; Edema *et al.*, 1997). Total crop failure as a result of some of these diseases have been reported in Uganda (Edema and Adipala, 1996). The objective of this study was to screen for possible sources of resistance to false rust and scab, two important diseases of cowpea in Uganda.

Materials and methods

The study was conducted at Kabanyolo (O°28'N, 32°37'E, 1,200m above sea level) and Serere (33°27'E, 1°31'N; 1,000 m above sea level) during the first season (March – June) and the second season (September – December) rains of 1994. About 33 to 230.6 mm (first season), and 94.9 to 210 mm (second season) was recorded at Kabanyolo during the growth period f the crop with a mean of 110.1 mm per month for the 1994 season. Mean daily maximum and minimum temperatures were 28.5°C and 13°, respectively. Soils are heavy, well drained and rather acidic (pH 5.0 – 6.0).

In the first and second seasons, 149.1 to 236.3 mm and 2.7 to 142 mm of rainfall, respectively, was

recorded at Serere with a mean of 123.2 mm per month for the 1994 season. Daily maximum and minimum temperatures averaged 27.5° and 22.5°C, respectively. Soils are sandy loams, with a pH of 5.5 – 6.5.

Establishment of experiments

Land used for the experiments was previously under cowpea for Kabanyolo, and under sorghum for Serere during both first and second rainy seasons, respectively. Fifty-four cowpea lines obtained from the International Institute of Tropical Agriculture (IITA) and eight local landraces from Uganda were used. The cowpea lines were planted in single-row plots of 3 m with a spacing of 60 cm between rows and 30 cm within rows. The experiment was of a randomised complete block design (RCBD) with two replications. Planting date was 27 April 1994 for Kabanyolo during the first rainy season. For the second season, planting dates were 23 October 1994 and 13 October 1994 for Kabanyolo and Serere, respectively. For each season susceptible entries were grown around experimental plots two weeks prior to planting the test lines. This was done so as to increase disease pressure. About 3 – 4 seeds were planted in each hole and the seedlings thinned to one plant per hill when plants were about 10 cm high. The experiment was weeded 2 – 3 times using a hand-hoe. During the second rains of 1994 Dimethoate (systemic) was applied at the rate of 20 ml/15l, and Decis (contact) at the rate of 50 ml/ 15 L to control insect pests. The insecticides were applied as tank-mixtures. Spraying was done at 7 – 10 day intervals commencing and 21 days after planting in Kabanyolo and 23 days after planting in Serere.

Data collection and analysis

Disease data were collected 67, 74 and 88 days after planting (DAP) in Kabanyolo during the first season, and 63, 70 and 79 DAP, and 46, 55 and 61 DAP for Kabanyolo and Serere during the second season, respectively. Five plants in each row were randomly selected, tagged and used for diseases assessment. Disease severity was rated using a modified Horsefall and Barret (1945) scale of 0, 1, 5, 10, 25, 50 and 75% of plant area affected. At maturity five plants from each row were harvested and the dry pods threshed and weighed.

The weekly severity ratings were averaged for each genotype and replicate, and areas under disease progress curves (AUDPCs) calculated and standardised (Campbell and Madden, 1990). Analyses of variance (ANOVA) were performed on disease and pod yield data using the one factor RCBD of M-Statc package (Russel D. Freed, Michigan State University, USA).

The varieties were classified as either resistant, moderately resistant, moderately susceptible or susceptible on the basis of their standardised Z-scores (Pataky and Darin, 1993). The Z-scores were calculated as Z = [(AUDPC-grand mean)/ standard deviation]. Lines with a Z-score > 0.8 were rated susceptible while those with scores < 0.8 were rated resistant. The moderately resistant and moderately susceptible lines had scores ranging from –0.2 to –0.8 and 0.2 to 0.8, respectively.

Results and Discussion

During the study period the following diseases were observed; false rust (*Synchytrium dolichi*), scab (*Sphaceloma* sp.), Dactuliphora leaf spot (*Dactuliophora tarri*), brown rust (*Uromyces phaseoli (Pers.)* Wint. and powdery mildew (*Erysiphe polygoni* de Candole). There was low severity of Dactuliophora leaf spot (0.12%), powdery mildew (0.68%) and brown rust (0.04%) in both seasons of 1994. This was probably due to the low rainfall (data not shown) which limited the infection process and development of the diseases. However, scab developed sufficiently well in both seasons and false rust during the second season at Serere to enable evaluation of varietal differences. The two diseases

appeared after the vegetative stage and were, therefore, scored from flower initiation to pod maturity: at this stage both scab and false rust symptom build-up is very rapid and symptoms are clearly visible.

There were significant differences ($P \leq 0.05$) among the lines in each of the two locations and disease levels varied significantly ($P \leq 0.05$) with season in Kabanyolo. In the first season, at Kabanyolo, scab severity ranged from 0 to 27.5% with an overall mean of 3.2%. Area under disease progress curve ratings (AUDPC) ranged from 8.5 to 20.2% for susceptible lines, 3.9 to 7.4% for moderately susceptible lines, 0.01 to 2.2% and 2.9 – 3.2%, for resistant and moderatly resistant lines, respectively. Based on the Z-scores 6 lines were rated susceptible, 13 moderately susceptible and 32 moderately resistant (Table 1). The lines IT86D-2014-1, IT88DM-363 and IT*(KD-245) were grouped as moderate resistant.

In the second season, the mean scab severity ranged from 1.1 to 41.0% with a mean of 17.6% at Kabanyolo. There was generally higher severity of scab in the second season compared to the first. This was attributed to the fact that the lines were grown in the field which was used for cowpea in the first season. Most likely, infested residue from the previous cowpea crop induced disease development (Singh and Allen, 1979; Nakawuka and Adipala, 1997). Thirteen (13) lines were rated susceptible, 9 moderately susceptible, 15 moderately resistant and 13 resistant during this season. These lines had Plant leaf araea affected (PLAA) rating of 29.8 – 48.3%, 20.8 – 28.1%, 11.6 – 17.9%, 2.6 – 9.6% and 19.1%, respectively. The 15 moderately resistant lines included TVU 11426, IT92KD – 258 – 9, IT89KD – 256, IT81 – 985, IT845 – 2246 – 4, IT87D – 941 – 1, IT91K – 93 – 10, IT90K – 76, IT92KD – 267 – 2, IT81D – 988, IT89KD – 355, IT89KD – 404-1, *Osu* (Arua) and *Amul* (Nebbi), while the 12 resistant lines included IT85D-3850-2, IT81D-994, IVX 1948-01F, TVU 11424, IT90K-56, IT86F-2062-5, IT92KD-404-1, *Ebelat* (Kumi), *Ebelat* (Bukedea), *Ebelat* (Butebo), *Icirikukwai* (Usuk) and *Icirikukwai* (Amuria).

In Serere 13 lines were rated susceptible to scab, 7 moderately susceptible, 25 moderately resistant and 9 resistant. These lines had PLAA ratings of 29.8-48.3%, 20.8-28.1%, 19.1-19.9%, 11.6-17.9% and 2.6-9.6%, respectively. The moderately resistant lines included IT92KD-258-9, IT85D-3850-2, IT89KD-260, IT81-994, IT81-985, TVX 1948-0IF, TVU 11424, IT90K 59, IT845-2246-4, IT87D-941-1, IT91K-118-20, IT91-93-10,IT90K-76, IT92KD-267-2, IT86F-2062-5, IT86D-880, IT8ID-1228-14, IT86F-2089-5, IT86D-715, IT89KD-391, IT81D-988, IT92KD-404-1, *Ebelat* (Kumi), *Osu* (Arua), *Amul* (Nebbi), *Ebelat* (Butebo) and *Icirikukwai* (Amuria). Five lines, namely IT89KD-288, TVU 4630, IT89KD – 355, *Ebelat* (Bukedea) and *Icirikukwai* (Usuk) were rated resistant.

More scab was observed in the second (mean 19.5%) than the first rainy season (mean 3.1%) in Kabanyolo. In a previous study, Iceduna *et al.* (1994) also consistently observed higher scab incidence and severity during the second season for reasons that have not yet been fully elucidated. Apparently, attack by scab is favoured by dry rather than wet weather. It may also be true that the low incidence of other fungal diseases during the second season reduced competition for surface area, hence scab flourished.

The main objective of the screening test was to isolate within the available germplasm lines that contain resistance to the specific diseases. Overall, therefore, seven lines namely, IT90-109, IT88D-643-1, IT92KD-263-4-1, IT90K-109, IT89KD-374-59, IT87-697-2 and IT88D-867 – were consistently rated susceptible to scab; six lines, i.e., IT89KD-245, IT86D-1010, IT83S-889, IT89KD-349 and IT88DM-3636 were rated moderately susceptible; 17 lines, namely, TVU 11426, IT92KD-258-9, IT85D-3850-2, IT8ID-994, IT81D-985, TVX 1948-01F, IT89KD-288, TVU 11424, IT90K-76, IT86F-2098-5, IT81D-988, IT89KD-355, IT92KD-404-1, *Ebelat* (Bukedea), *Amul* (Nebbi), *Ebelat* (Butebo) and *Icirikukwai* (Usuk) were rated resistant. In the previous study of Iceduna *et al.* (1994), the lines IT85D-3850-2, IT81D-994 and TVX 1948-O1F were classified as resistant.

There was very low incidence of false result in Kabanyolo, but higher levels developed in Serere (Table 2). As such, only data for Serere were used to rank the cowpea lines for resistance to false rust. Three (3) lines were rated resistant, 31 moderately resistant, 7 were considered moderately susceptible,

Table 1. Z-scores[a] for 62 cowpea lines evaluated for resistance to scab at Kabanyolo and Serere during the first and second seasons of 1994.

	Kabanyolo				Serere	
Entry	First season[b]	Reaction	Second season[b]	Reaction	Second season[b]	Reaction
TVX 4659-03E (Dc)	-0.5	MR	-	-	-	-
TVU11426 (D)	-0.5	MR	-0.5	MR	-0.9	R
IT92KD-258-9 (D)	-0.5	MR	-0.6	R	-0.5	MR
IT85D-3850-2 (D)	-0.5	MR	-1.1	R	-0.7	MR
IT89KD-256 (D)	-0.5	MR	1.1	S	-0.3	MR
IT89KD-256	-0.5	MR	-0.4	MR	0.1	MS
IT81D-994 (D)	-0.5	MR	-0.8	R	-0.4	MR
IT81D-985 (M/D)	-0.5	MR	-0.2	MR	-0.7	MR
TVX 1948-01F (D)	-0.5	MR	-1.1	R	-0.5	MR
IT89KD-288 (D)	-0.5	MR	0.0	M	-0.8	R
TVU4630 (D)	-0.5	MR	-1.1	R	-0.9	R
IT91K-45 (D)	-0.3	MR	-	-	-	-
IT89KD-245 (M/D)	0.3	MS	1.1	S	0.4	MS
TVU 11424 (D)	-0.5	MR	-1.0	R	-0.7	MR
TVU 12349 (D)	-0.5	MR	-	-	-	-
IT90K-59 (S/I/E)	1.1	S	0.6	MS	-0.3	MR
IT90-109 (I)	2.9	S	0.6	MS	1.0	S
IT92KD-371-1 (E)	0.9	S	-	-	-	-
IT845-2246-4 (E)	1.0	S	-0.2	MR	-0.2	MR
IT86D-1010 (E)	-0.2	MR	0.4	MS	1.3	S
IT87D-941-1 (E)	0.3	MS	-0.5	MR	-0.8	MR
IT86D-719 (E)	-0.2	MR	0.9	S	0.8	MS
IT88D-643-1 (E)	-0.2	MR	1.0	S	2.6	S
IT90K-56 (E)	0.2	MS	-1.1	R	-0.7	MR
IT91K-118-20 (E)	-0.5	MR	0.1	MS	-0.4	MR
IT90K-102-6 (E)	-0.5	MS	-0.9	R	1.1	S
IT91K-93-10 (E)	0.4	MS	-0.3	MR	-0.7	MR
IT90K-76 (S/E)	-0.5	MR	-0.5	MR	-0.8	MR
IT92KD-267-2 (V)	0.5	MS	-0.3	MR	0.2	MS
IT92KD-266-2-1 (V)	-0.5	MR	-	-	-	-
IT86F-2062-5 (V)	-0.2	MR	1.1	S	-0.5	MR
IT86D-880 (V)	-0.3	MR	0.6	MS	-0.4	MR
IT83S-889 (V)	0.3	MS	0.0	M	1.6	S
IT81D-1228-14 (V)	0.3	MS	2.2	S	-0.1	MR
IT92KD-263-4-1 (V)	0.2	MS	1.1	S	2.0	S
IT86F-2089-5 (V)	-0.3	MR	-1.3	R	-0.4	MR
IT86D-2014-1 (V)	0.0	M	0.0	M	-0.4	MR
IT88D-643-1 (S/M)	-0.5	MR	0.8	S	1.4	S
IT90K-109 (E/M)	-0.2	MR	1.0	S	0.9	S
IT86D-719 (M)	-0.5	MR	1.4	S	0.7	MS
IT89KD-374-57 (I)	0.1	MS	0.8	S	1.0	S
IT89KD-349 (M)	0.3	MS	0.7	MS	0.8	MS
IT86D-715 (M)	0.4	MS	2.1	S	-0.2	MR
IT87D-697-2 (M)	1.8	S	0.9	S	0.2	MS
IT88DM-363 (M)	0.0	M	0.5	MS	1.2	S
IT89KD-391 (I/M)	1.1	S	0.5	MS	-0.3	MR
IT81D-988 (M)	-0.5	MR	-1.0	MR	-0.8	MR
IT90K-277-2 (I)	0.6	MS	-	-	-	-
IT88D-867-11 (M)	0.3	MS	0.7	MS	1.3	S
IT/89KD-355 (M)	-0.3	MR	-0.2	MR	-0.9	R
IT89KD-245 (M)	0.0	M	0.0	M	0.2	MS
IT92KD-405-2 (S/M)	-0.5	MR	-	-	-	-
IT89KD-260 (M)	-0.5	MR	-0.1	MR	0.3	MS
IT92KD-404-1 (S/M)	-0.5	MR	-0.3	MR	-0.4	MR
Ebelat (Kumi)*	-	-	-0.9	R	-0.5	MR

Table 1. cont.

Osu (Arua)*	-	-	-0.2	MR	-0.4	M.R
(Bukedea)*	-	-	-1.3	R	-0.9	R
Icirikukwa	-	-	-	R	-	R
I(Usuk)			1.2		0.9	
Amul (Nebbi)*	-	-	-0.5	MR	-0.1	MR
Ebelat	-	-	-0.9	R	-0.6	MR
Icirikukwai (Amuria)*	-	-	-1.1	R	-0.5	MR

[a]
[b] Calculated as: [AUDPC rating-grand mean)/standard deviation]
<-0.8 = resistant, -0.2 to –0.8 = moderately resistant, 0.2 to 0.8 = moderately susceptible, between –0.2 to 0.2 [c] moderate and >0.8 = susceptible
[d] D = Dual purpose line (both for seed and vegetable), E = Early maturing line, I = Insect resistant line, S = Striga resistant line, M = medium length maturing line and V = lines for vegetable.
* Local cultivars

Table 2. Z-scores[a] for 62 cowpea lines evaluated for resistance to false rust at Serere during the second season of 1994.

Entry	Z-score	Reaction[b]
TVX 4659-03E (Dc)	-[d]	-
TVU 11426 (D)	0.3	MR
IT92KD-258-9 (D)	1.5	S
IT85D-3850-2 (D)	0.0	MS
IT89KD-260 (D)	-0.5	MR
IT89KD-256 (D)	-0.1	MS
IT81D-994 (D)	-0.5	MR
IT81D-985 (M/D)	-0.2	MR
TVX 1948-01F (D)	1.2	S
IT89 KD-288 (D)	-0.2	MR
TVU 4630 (D)	1.9	S
IT91K-45 (D)	-	-
IT89KD-245 (M/D)	-0.6	MR
TVU 11424 (D)	1.1	S
TVU 12349 (D)	-	-
IT90K-59 (S/I/E)	-0.8	MR
IT90-109 (I)	-1.0	MR
IT92KD-371-1 (E)	-	-
IT845-2246-4 (E)	-0.1	MR
IT86D-1010 (E)	-0.2	MR
IT87D-941-1 (E)	0.0	MR
IT86D-941-1 (E)	0.0	MR
IT86D-719 (E)	-0.6	MR
IT88D-643-1 (E)	-1.0	R
IT90K-56 (E)	-1.2	R
IT91K-118-20 (E)	1.7	S
IT90K-102-6 (E)	-0.8	R
IT91K-93-10 (E)	2.2	S
IT90K-76 (S/E)	-0.1	MR
IT92KD-267-2 (V)	-0.8	MR
IT92 KD-266-2-1 (V)	-	-
IT86F-2062-5 (V)	0.6	MS
IT86D-880 (V)	-0.1	M
IT83S-889 (V)	-0.4	M

Table 2. Cont.

IT81D-1228-14 (V)	-0.1	M
IT92KD-263-4-1 (V)	-1.0	MR
IT86F-2089-5 (V)	1.0	S
IT86D-2014-1 (V)	-0.7	MR
IT88D-643-1 (S/M)	-0.8	MR
IT90K-109 (E/M)	-0.3	MR
IT860-719 (M)	-0.3	MR
IT89KD-374-57 (I)	-0.5	MR
IT89KD-349 (M)	-0.7	MR
IT86D-715 (M)	-0.3	MR
IT87D-697-2 (M)	-0.8	MR
IT88DM-363 (M)	-0.8	MR
IT89KD-391 (I/M)	0.5	MS
IT81D-988 (M)	-0.5	MR
IT90K-277-2 (I)	-	-
IT88D-867-11 (M)	-0.4	MR
IT89KD-355 (M)	-0.1	MR
IT89KD-245 (M)	-0.4	MR
IT92KD-405-2 (S/M)	-	-
IT89KD-260 (M)	-0.5	MR
IT92KD-404-1 (S/M)	-0.1	MS
Ebelat (Kumi)*	0.8	S
Osu (Arua)*	1.7	S
Ebelat (Bukedea)*	1.0	S
Icirikukwai (Usuk)*	1.2	S
Amul (Nebbi)*	0.9	MS
Ebelat (Butebo)*	0.6	MS
Ebelat (Butebo)*	0.6	MS
Ebelat (Apopong*)	-0.8	-

[a] Calculated as: [(AUDPC rating-grand mean)/standard deviation

[b] <-0.8 = resistant, -0.2 to –0.8 = moderately resistant, 0.2 to 0.8 = moderately susceptible, between –0.2 to 0.2 = moderate and > 0.8 = susceptible

[c] D = Dual purpose line (both for seed and vegetable), E = Early maturing line, I = Insect resistant line, S = Striga resistant line, M = Medium length maturing line and V = lines for vegetable.

[d] Didnot germinate

[e] *Local cultivars

and 9 susceptible (Table 2). The three resistant lines were IT88D-643-1, IT90K-56 and IT90K-1026. The majority of the local landraces were susceptible to false rust.

These tests relied on natural inocula of the diseases and some of the lines did not always fall into the same resistance/susceptibility category in all seasons (Tables 1 & 2). Nevertheless, the present results suggest that the local landraces had low scab but high false rust infections. The low severity of scab observed on *Amul* and *Osu* and the low levels of false rust observed during the surveys (Edema *et al.*, 1997) on all the varieties could be a result of many factors, but to some extent, might reflect local specificity of the diseases in question.

Variable levels of susceptibility and partial resistance to both scab and false rust have been demonstrated (IITA, 1978; Mukalere, 1989; Iceduna *et al.*, 1994), and resistance has been shown to be highly heritable to these diseases (IITA, 1978; Nakawuka and Adipala, 1997). Therefore, future breeding programmes should consider incorporating resistance to false rust into high yielding local and elite cultivars. Also lines showing multiple resistance to false rust and scab should be used in cowpea improvement programmes. This is particularly important since the majority of farmers in Uganda can not afford use of chemical sprays.

Fourteen lines have been selected on the basis of higher yield potential and resistance to either scab or false rust, or both (Tables 1 & 2). These lines had other valuable attributes . For example, under the IITA conditions in Nigeria, TVU 11426, IT81D-985, TVX 1948-01F, IT89KD-288, TVU 4630, IT89KD-245, TVU 11424 were high seed yielders and good as vegetable; lines IT81D-985, IT89KD-245, IT88D-643-1, IT87D-697-2 and IT88DM-363 had a medium maturity; IT86D-1010 and IT88D-634-1 were early maturing lines; IT90K-109 and IT89KD-374-57 were insect resistant; IT92KD-263-4-1 was good for vegetable while IT88D-643-1 was resistant to striga (*Striga gesnerioides* (Wild.) Vatke). Three of these lines, namely, TVU 11426, IT81D-985 and IT89KD-288 were not only high yielders, but also resistant to both scab and false rust.

However, additional studies, especially under controlled conditions need to be done to confirm the yield potential, pest resistance, striga resistance and diseases resistance of the promising genotypes.

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