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Evaluation of Improved Cowpea Genotypes for Yield and Resistance to Scab Disease in Uganda

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Abstract

Cowpea is one of the most important legume food crops in Uganda. However, grain yields as low as 400 kg ha−1 have been recorded in farmers' fields despite a grain yield potential of 3,000 kg ha−1. Cowpea scab is a major production constraint, causing yield losses of up to 100%. Three hundred ninety (390) improved cowpea genotypes were evaluated for yield and scab resistance for one (1) year at NaSARRI, Serere, Uganda using an alpha lattice design with two replications. The analysis of variance showed significant differences ($p < 0.05$) for grain yield, scab severity, incidence, and area under disease progress curve (AUDPC) among genotypes, seasons, and for genotypes by seasons interactions. The mean grain yield of 981.6 kg ha−1 was recorded across the cowpea genotypes with genotype, TVU-1280 having the highest grain yield of 1790.8 Kg ha−1. The cowpea genotypes; 1195K-1093-5-A, TVU-2968, SanZi, Taef-14-inhaca.E, TVU-205-8 and TVU-13485 had low scab severity(range:8.0 - 9.0).Cowpea genotypes; Taef-14-inhaca.E(33.7%), TVU-14633(26.7%), TVU-151144(30.6%), and Cosiriele (31.4%), had low scab incidence. Low AUDPC (range: 788.8-883.5) was observed in cowpea genotypes; 1195K-1093-5-A (775.0), TVU-2968(788.8), TVU-14633-A (883.8), and TVU-13388 (857.5). Grain yield had a significant negative correlation with AUDPC ($r = -0.2279$, $p < 0.001$) and scab severity (-0.600, $p < 0.001$). Scab severity showed a strong significant and positive correlation with AUDPC ($r = 0.6873$, $p < 0.001$). The cowpea genotypes; 1195K–1093–5–A, TVU–2968, TVU–15114, SanZi, and Taef–14–inhaca.E could be used as breeding lines for introgressing scab resistance into cultivars with farmer preferred traits.

Keywords: Alpha Lattice Design; Area Under Disease Progress Curve (AUDPC); Scab Incidence; Scab Severity; Screening

Abbreviations: AUDPC: Area Under Disease Progress Curve; FAO: Food and Agricultural organization; NaSARRI: National Semi Arid Resources Research Institute; IITA: International Institute of Tropical Agriculture; ANOVA: Analysis of Variance; LSD: Least Significant Difference; CV: Coefficient of Variation; NSP: Number of Seeds per Pod; NPP: Number of Pods per Plant; DTF: Days to Flowering; DTM: Days to Maturity.

Introduction

Cowpea, which is ranked the third important staple legume crop after soybeans and common beans is valued for its richness in proteins [1]. The dry cowpea grain contains

23 – 32% protein and essential amino acids [2]. The green cowpeas seeds, fresh and immature pods, and leaves contribute vegetable sources for human consumption [3]. The Food and Agricultural organization (FAO) estimated 9.8 million metric tonnes of cowpea grains was produced worldwide by 2020 (FAOSTAT, 2020). The same report indicates that Nigeria produced about 2.6 million metric tonnes of cowpea grains making it the leading producer in the world while Uganda is ranked number eighteen among the top twenty cowpea producing countries in the world with 12.4 million metric tonnes. It is also a key leguminous crop in other arid and tropical regions of Africa, Asia, and Latin America [4].

Although the production and demand of cowpea grains is increasing, its yield has remained as low as 400 kg ha−1 below the potential (3,000 kg ha−1) mainly attributed to both biotic and abiotic factors [5]. The abiotic factors include; drought, salinity, temperature, water logging [6-10]. The biotic factors include; parasitic weed such as striga, insect pests such as pod borers, aphids, root knot nematodes, viral diseases such as cowpea mottle virus, cowpea yellow mosaic comovirus, bacterial diseases such as bacterial blight, as well as fungal diseases such as blight, wilt, powdery mildew, dry root rot [11]. Other socio–economic constraints limiting cowpea production include; market failures and limited access to improved varieties on account of challenges in the seed systems [12].

Cowpea scab (*Sphaceloma sp*) is one of the most destructive and persistent fungal diseases of cowpea [5]. It is widespread in Sub Saharan Africa and very damaging in Savannah areas of semi–arid environment with moderate temperatures of about 23 – 28°C, with three or more consecutive days of wet weather resulting in high relative humidity [5]. The disease affects all the above ground parts of cowpea, capable of causing yield losses of up to 100% [13]. Currently, there is a resurgence of the cowpea scab disease in Uganda [5]. The authors reported that only one out of the five improved cowpea cultivars recently released by National Semi Arid Resources Research Institute (NaSARRI) is moderately resistant and even not readily available to most farmers in Uganda. As a result, majority of the farmers grow local varieties there by fueling the scourge of the disease. In addition, many farmers have resorted to excessive use of synthetic fungicides to control the spread and effect of the disease. Repeated use of fungicides in cowpea production causes high levels of chemical residues in harvested produce, pest and disease resurgence, and pollution of the environment [14]. However, host resistance was used in the management of Pecan Scab in South Western United States of America [15]. More still, most farmers in Uganda have not adopted appropriate control measures [5]. The use of host resistance is the most practical control approach against cowpea scab disease [16]. Therefore, this leaves room for this current study to screen wide range of available improved cowpea genotypes for sources of resistance against scab disease with farmer preferred traits.

Methodology

Study Area

The screening experiment was conducted on–station at National Semi Arid Resources Research Institute (NaSARRI), Serere, Eastern Uganda at coordinates of 1°39'North and 33°27'East; and at latitude of 1038 meters above sea level, for two (2) consecutive rain seasons of September–December 2020 (season 2020B) and the first rains of March–July (2021A). The soils fall mainly under four major units; Serere catena; Metu complex series. These are mainly of the ferralitic type with well drained and friable sandy loam.

Experimental Design

Three hundred ninety (390) selected improved cowpea genotypes consisting of both resistant and susceptible cultivars obtained from International Institute of Tropical Agriculture (IITA) were used in this study. The field layout was an alpha lattice design with two (2) replications. A distance of 1.5 m was maintained between main blocks and 1m between sub plots to act as buffers. The individual plot size of 2 m × 1 m was used, and cowpea genotypes planted at spacing of 60 cm x 30 m, with 2 seeds per hill and later thinned to one (1) plant/hill at 0.15 m high (at first weeding). The fields were weeded twice and sprayed with insecticide chlorpyrifos (Dursban) at the interval of one (1) week to control insect pests, especially aphids, pod–sucking bugs and pod borers which are common before flowering and during flowering. Fertilizer and fungicides were not applied during the entire growing period.

Cowpea Scab Disease Incidence and Severity Analysis

Data on disease incidence and severity were collected at 10 days interval. Using Simple random sampling method, five (5) plants were randomly selected from the inner rows of each plot and tagged for continuous data collection on disease severity using a rating scale of 1–5 developed by Nakawuka CK, et al. [17]. The mean severity scores were estimated using microsoft excel, and the means obtained were used to calculate Area under the disease progress curve (AUDPC) for each of the cowpea genotype in microsoft excel using the formula of Campbell CL, et al. [18].

$$AUDPC = \sum_{i=1}^{N=1} 0.5\left(y_i + y_{i+1}\right)\left(t_{i+1} - t_i\right)$$

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Where “t” is the time of each reading between two consecutive assessments in days, “y” is the percent of affected foliage at each reading and “n” is the number of readings. The variable “t” represents days after planting. The area under disease progress curve (AUDPC) was used to measure resistance of the cowpea genotypes.

Growth and Yield Determination

Data on agronomic traits such as plant height (cm), days to 50% flowering, days to 75% maturity, and other yield related traits such as pod length (cm), number of pods per plant, number of seeds per pod and grain yield (Kg ha−1) were collected from five (5) plants tagged in each plot.

Statistical Analysis

The mean grain yield and yield components were estimated using Microsoft excel, and the means were subjected to the analysis of variance (ANOVA) using Gemstar 13th edition to generate means, least significant difference (LSD), percentage coefficient of variation (CV) and F–probability values. The Treatment means were compared using Duncan least significant difference test at 5% significance level.

Results

The analysis of variance Table 1 showed significant differences (P<0.05) for grain yield, scab severity and area under disease progress curve (AUDPC) across genotypes, season, and genotype by season interaction except scab incidence for genotype by season interaction. Other assessed agronomic traits such as plant height (PH), days to 50% flowering (DTF), days to 75% maturity (DTM), number of pods per plant (NPP), pod length (PL) and number of seeds per pod (NSP) were not significant at (P<0.05).

SOV	DF	DTF	NPP	NSP	PL (cm)	DTM	PH (cm)	GYD (Kg ha^{-1})	SI (%)	SS (%)	AUDPC
G	389	56.09 ns	505.8ns	4.845ns	6.079ns	19.02ns	55.48ns	141009 ***	117.99*	15.0050***	69276***
S	1	116.02ns	94.7ns	35.101ns	56.731ns	2378.26ns	1.29ns	48718914***	1435.93***	3744.629***	36248553***
G*S	389	57.11ns	476.1ns	4.651 ns	6.497 ns	53.59ns	19.28ns	105215***	99.70ns	17.8060***	77571***
Se		7.531	23.449	2.088	2.4423	7.504	7.484	268.27	9.06	2.8951	219.18
Lsd (0.05)		14.750ns	46.031ns	4.0989ns	4.7944ns	14.732ns	14.691ns	526.62***	19.367ns	5.6832***	430.26***
CV (%)		17	16.4	16.8	17.4	11.7	21.2	30.1	28.6	23.6	19.8

DF = degrees of freedom, Values with * and *** implies significant at P<0.05, P< 0.001 respectively and ns = Not significant at 0.05 level, CV = coefficient of variation, Lsd = least significant difference, Se = standard error, SOV = source of variation, DTF = days to 50% flowering, DTM = days to 75% maturity , NPP = number of pods per plant , NSP = number of seeds per pod , PL = pod length, GY = grain yield, AUDPC = area under disease progress curve, PH = plant height, G = genotype, S = season, G*S = genotype by season interaction, SI = Scab incidence, SS = Scab severity.

Table 1: Mean squares and significant tests for grain yield and yield components measured in 390 improved cowpea genotypes at NaSARRI, Serere.

The area under disease progress curve was relatively low across the top 15 genotypes except genotypes; TVU-14633 (1030.0), TVU-205-8 (1057.5), respectively. The scab incidence was also relatively high across the top 15 genotypes ranging from 26.7 to 43.9%. The second rain season of 2020 (2020B) recorded the highest mean of scab severity (14%) compared to first rain season of 2021 (2021A) with mean scab severity of 11%. The lowest scab severity was recorded in genotypes, 1195K-1093-5-A (6%) followed by TVU-1330 (7%) respectively in 2020B while in 2021A, the cowpea genotypes, TVU-2968 (8%), and 11845-2049-A (8%) recorded the lowest scab severity (Table 2).

GENOTYPES	SS 2020B	SS 2021A	Mean SS	Rank	AUDPC	SI (%)	GY (Kgha^{-1})
Top fifteen (15) Genotypes							
1195K-1093-5-A	6	9	8	R	775	40.9	474.5
TVU-2968	9	8	8	R	788.8	33.8	678.9
TVU-15114	8	9	8	R	937.5	30.6	914.8
SanZi	9	9	9	R	990	37.3	1541.3

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TVU-1330	7	11	9	R	962.5	42.1	1042.8
TVU-13388	8	10	9	R	857.5	33	1181
TVU-14633	7	11	9	R	1030	26.7	879.1
TVU-205-8	9	9	9	R	1057.5	37	687.6
TVU-13485	9	9	9	R	938.8	38	1177.4
TVU-14633-A	9	9	9	R	883.8	39.2	697.2
UCR-5219	8	10	9	R	961.3	36.8	1050.5
TVU-1583	7	11	9	R	1040.1	32.2	709
11845-2049-A	10	8	9	R	1065	43.9	805
Cosiriele	10	8	9	R	1300	31.4	919.1
Taef-14-inhaca.E	9	9	9	R	950	33.7	1392.5
Bottom five (5) Genotypes							
TVU-6642	18	16	17	MS	1185	35.2	1272.4
Vg-58	18	17	17	MS	1395	32.4	612.1
TVU-4711	22	14	18	MS	1376.3	30.8	576.9
UCR-162-A	21	16	18	MS	1406.3	37.1	792.6
TVU-9506-A	22	16	19	MS	1408.8	43.3	649.2
Mean	14	11	12		1109.5	34.4	891.6
Se			2.0472		304.24	4.933	134.77
Lsd(0.05)			5.6832***		430.26***	13.694*	374.15***
CV (%)			23.6		19.8	28.6	30.2

SS = Scab severity, SI = Scab incidence, B = Second season of 2020, A = First season of 2021, CV = coefficient of variation, Lsd = Least significant difference, Score scale of 1-5, 1 = 0%, 2 = less than 10%, 3 = 10-20% 4 = 20-30% and 5 = more than 50%, R = Resistant, MS = moderately susceptible.

Table 2: Mean values for Scab severity and AUDPC among the top fifteen (15) best and bottom five (5) worst performing genotypes after evaluating 390 improved cowpea genotypes at NaSARRI, Serere for two seasons.

The highest mean grain yield of 891.6Kg ha^{-1} was recorded across the cowpea genotypes. Cowpea genotype, TVU-1280 was ranked as the best performed genotype with the grain yield (1790.8Kg ha^{-1}), followed by genotype, CP-4877 (1626.5Kg ha^{-1}) respectively. Based on season performance, the mean cowpea grain yield of 1069.4 Kg ha^{-1} was recorded in season 2020B and 713.8Kg ha^{-1} in season 2021A. The highest grain yields were recorded in genotypes, SanZi (2383.8Kg ha^{-1}), followed by 1198K-555-1(2234.8Kg ha^{-1}) respectively in season 2020B while in 2021A, the cowpea genotypes, TVU-1280(2550Kg ha^{-1}), CP-4877(1512.3Kg ha^{-1}) respectively, recorded the highest grain yield (Table 3).

GENO TYPES	B	A	Mean Grain yield (Kgha-1)	Rank	Days to 50% Flowering	Days to 75% Maturity	Plant Height (cm)	Number of Seeds Per Pod	Pod length (cm)	Scab severity (%)	Scab incidence (%)	AUDPC	Number of pods per plant
Top Fifteen (15) Genotypes													
TVU-1280	1031.6	2550	1790.8	1	40.8	67.3	30.7	12.5	14.1	11.3	32.2	1136.3	155.8
CP-4877	1740.7	1512.3	1626.5	2	41.5	70.5	36.7	12.8	14.9	13.5	32.2	1196.3	156
SanZi	2383.8	698.7	1541.3	3	42.3	66.8	37.7	14	14.1	8.5	37.3	990	135.3
TVU-14172	1752.1	1082.9	1417.5	4	43.8	65.8	38	12.5	13	13.5	31.7	940	122.3
Taef-14-inhaca.E	1968.3	816.7	1392.5	5	40.8	66.3	31.9	11.5	12.5	9	33.7	950	143.3
1198K-555-1	2234.8	506.4	1370.6	6	41.3	62.8	30.3	11.5	15.1	13.3	27	1135	133.5

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UCR 830-A	1675.4	941.5	1308.5	7	44	46.5	45	16.4	17.4	11.7	29.4	1298.7	139.8
TVU-3552	1562.2	1047.6	1304.9	8	42	63.8	33.6	13.3	14.8	13.3	28.2	1030	150.8
TVU-15391-A	1847	711.1	1279.1	9	43.3	65.3	32.8	12	13.8	10	27.9	996.3	137.5
TVU-6642	1429.3	1115.5	1272.4	10	41	70	35.9	12	14	17	35.2	1185	139.8
TVU-14621	1223.5	1313.9	1268.7	11	43	66.3	37.3	14	16.6	11.5	38	1112.5	152.5
Yacine-C	1701.4	820.7	1261.1	12	42.5	64.3	24.2	11.8	14.8	12.5	35.3	1173.8	124
TVU-14971	1589.5	917.1	1253.3	13	43	68.3	38.6	12.3	12.8	10	42.5	868.8	161
TVU-16521	1327.2	1150.8	1239	14	42.8	66	34.1	11.5	14.9	12.3	35.2	1161.3	151
UCR-739	1606.6	856.5	1231.6	15	42.8	64.8	31.4	15	15.5	10.5	34.4	978.8	156.5
Bottom Five (5) Genotypes													
Apag LaaLa	555.9	496.6	526.3	386	43	67.8	40.9	11.3	12.1	12.3	35	1213.8	130
TVU-1469-1	510.1	496.6	503.4	387	41.8	62.5	37	11.5	14.8	14.5	27.3	1277.5	145.8
1195K-1093-5-A	524.7	424.2	474.5	388	42	67.3	39.4	11.3	14	7.5	40.9	775	132.5
Lig-321-2	528.6	377.2	452.9	389	41	68.8	34.7	12.5	16.2	14.3	43.1	1102.5	148.8
CP-4877-A	526.3	376.4	451.4	390	42.5	67.8	29.5	10.3	14.8	12.3	29.3	1146.3	133.5
Mean	1069.4	713.8	891.6		42.2	66.4	35.2	12.4	14	12.3	34.4	1109.5	143.3
Se			190.6		0.9336	3.03	5.292	1.044	2.0472	6.976	4.933	304.24	11.724
Lsd(0.05)			529.13***		2.5919**	8.411ns	10.388ns	2.8983ns	4.0186ns	19.367***	13.694*	430.26***	32.549ns
CV (%)			30.2		4.4	9.1	21.2	16.8	17.4	23.6	28.6	19.8	16.4

B = Grain yield in Second season of 2020, A = Grain yield in first season of 2021, CV = coefficient of variation, LSD = least significant difference, Se = standard error of means, DTF = days to 50% flowering, DTM = days to 75% maturity, NPP = number of pods per plant, NSP = number of seeds per pod, PL = pod length, GY = grain yield, AUDPC = area under disease progress curve, PH = plant height, SI = Scab incidence, SS = Scab severity.

Table 3: Mean values for grain yield (Kg ha-1) among the top fifteen (15) best and bottom five (5) worst performing genotypes after evaluating 390 improved cowpea genotypes at NaSARRI, Serere.

The partial correlation analysis for the assessed agronomic traits of 390 cowpea genotypes evaluated for two (2) seasons in NaSSARI, Serere is represented in Table 4. Grain yield had a significant positive correlation with days to 75 maturity (r = 0.1293, p<0.001), and plant height (r = 0.0475, p<0.05) except with area under disease progress curve (r = -0.2279, p<0.001). There was a strong significant and positive correlation between number of seeds per pod and the pod length (r = 0.5938, p<0.001). Days to 50% flowering was positively correlated with days to 75% maturity (r =0.1260, p<0.001) and number of pods per plant (0.0244, p<0.05). Scab severity showed a strong significant and positive correlation with area under disease progress curve (r = 0.6873, p<0.001) except with grain yield (r = -0.600, p<0.001). There was relatively low but a negative association between scab incidence (r =0.0381, p<0.05), area under disease progress curve (p<0.05, -0.0223) with plant height.

Traits	Pod length	Scab severity	Scab incidence	AUDPC	Days to 50% flowering	Days to 75% maturity	Plant height	Number of Seeds/ pod	Number of pods/ plant
Scab severity	-0.0123ns	-							
Scab incidence	0.0181ns	-0.0608ns	-						
AUDPC	-0.0383ns	0.6873***	-0.0821ns	-					
Days to 50% flowering	-0.0268ns	-0.0093ns	-0.0070ns	-0.0417*	-				
Days to 75% maturity	0.0068ns	0.0058ns	-0.1509ns	0.0115ns	0.1260***	-			
Plant height	-0.0374ns	0.0094ns	-0.0381*	-0.0223*	0.0662	-0.0130ns	-		

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No.Seeds/pod	0.5938***	-0.0454ns	0.0089ns	-0.0164ns	-0.0119ns	0.0488*	0.0074ns	-	
No.pods/ plant	-0.0473ns	-0.0254ns	0.0230ns	-0.0030ns	0.0244*	0.0147ns	0.0131ns	0.0108ns	-
Yield (Kg ha^{-1})	-0.0642ns	-0.600***	-0.0255ns	-0.2279***	-0.0017ns	0.1293***	0.0475*	0.0128ns	0.0600ns

AUDPC = area under disease progress curve, values with *, and *** implies significant at P < 0.05, and P < 0.001 respectively and ns = Not significant at 0.05.

Table 4: Phenotypic correlation coefficients among the ten (10) quantitative traits of 390 improved cowpea genotypes evaluated for two seasons at NaSARRI, Serere.

Discussion

Cowpea is the third most important legume food crop in Uganda. Low grain yield of about 400 kg ha^{-1} has been recorded in farmers' fields despite the grain yield potential of 3,000 kg ha^{-1} [5]. This has been attributed to several production constraints. For example, according to Kamara AY, et al. [19], Pratap A, et al. [20] and, cowpea production in Sub Saharan Africa is mainly under traditional systems with low grain yields due to long maturing varieties, limited access to improved varieties, poor soils, insect pests, diseases, and drought. Cowpea diseases caused by fungi, bacteria, viruses, nematodes and parasitic higher plants constitute one of the major constraints to cowpea production in Sub Saharan Africa [11,21]. Ojiewo CO, et al. [12] also reported that the low productivity of cowpea is attributed to various socio–economic constraints including, market failures and limited access to improved varieties on account of challenges in the seed systems.

The present study found high prevalence of cowpea scab disease in the field across the two seasons of 2020B and 2021A thus confirming that cowpea scab still remains a big threat among farmers in Uganda. The earlier studies showed that scab disease is the most important and destructive foliar disease of cowpea in Sub Saharan Africa and can cause yield losses of up to 100% [13]. The genotypes showed significant differences (p < 0.05) for grain yield, scab severity, scab incidence, and AUDPC (Table 1). This suggests that the germplasm pool harbor adequate genetic variation for cowpea scab for breeding cowpea scab disease resistance. This study clearly illustrates that there is wide variability in cowpea scab disease incidence and severity across the improved cowpea genotypes. These genotypes could be possessing different heritable genes that made them react differently to scab disease. The results agree with study conducted by Schneider KA, et al. [22], who reported that cowpea genotypes have varying tolerance and susceptibility levels to cowpea scab disease. Cowpea genotypes that recorded low cowpea scab disease incidence rates with low disease severity rates are highly desirable for disease improvement in cow pea. Significant difference was observed for scab incidence, severity and AUDPC across the seasons. Based on season performance, high mean scab severity (14%) and scab incidence (35.4%) was recorded in the second rainy season of 2020 (2020B) (Table 2). This is probably because of high rainfall and lower temperature experienced in 2020B that might have created higher relative humidity thus favouring development and sporulation of fungal diseases such as cowpea scab. High relative humidity implied long periods of leaf surface wetness which has been reported to favour the development and sporulation of fungal diseases [23,24]. According to Adandonon A, et al. [26], disease incidence and severity of cowpea stem rot was higher in the south and central zones of Benin Republic than its Northern zone during summer because of different amount of rainfall and temperatures received. The results agree with the findings that environments in humid agro–ecological regions are more conducive for the growth and development of fungal disease–causing agents Allen DJ [26], Adegbite A, et al. [27], Mbong GA, et al. [13] as observed in the current study. However, earlier studies by Talley SM, et al. [28] showed that scab disease is common in the seasons of low moisture content than in seasons of higher moisture content contrary to the current findings. This could also be due to factors relating to the host plant, the pathogen, and the environment interactions [29]. The occurrence and the intensity of cowpea scab disease are dependent on how these three factors interact. However, environmental factors have traditionally been considered to have the most impact on disease development [30]. According to Cooke RC, et al. [31], infection and disease occurrence of cowpea scab on plants are favoured by temperatures ranging between 12 – 40oC.

The top 15 genotypes ranked according to scab severity (low severity) had relatively low area under disease progress curve (AUDPC). The variation in the AUDPC and scab severity could be due to the interplay between the fungus (pathogen), host (cowpea genotypes) and environment, as have been earlier postulated by Agrios GN [29]. This could have also been due to inherent factors which control the ability of the plants to withstand fungal infection, fungal strain, and the time of infection. Studies conducted by Schuerger C, et al. [32] also revealed that the genetic background or environmental factors might influence the apparent relative effectiveness of the resistant genes of the plant, resulting in a lot of genotypes becoming susceptible to a fungal attack. The higher AUDPC recorded in the season 2020B (1262.0) compared to the season 2021A (957.1) (result not presented) could also be

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due to the lower temperatures and higher relative humidity experienced during the wet season (2020B) compared to the dry season (2021A) that might have influenced rapid disease development and suppressed the plasticity and recovery rate of the cowpea genotypes. Lower temperatures experienced in season 2020B might have also favoured rapid development of spores, and hence increased the chances of transmitting cowpea scab disease in the cowpea genotypes as seen in the current study.

In the present study, a significant ($p < 0.05$) correlation was exhibited between grain yield, days to 75% maturity, severity, plant height, and AUDPC (Table 4). Grain yield had a moderate positive correlation with days to 75 maturity and plant height. This implies that these traits can be improved concurrently through direct selection. However, significant negative correlation was observed between AUDPC and grain yield and other agronomic traits such as days to 50% flowering, and plant height. This was expected because as the scab disease progresses, it attacks the whole cowpea plant affecting plant growth and this also affects days to 50% flowering and plant vigour hence reduction in plant height. This in turn affects pod formation and grain filling duration hence low grain yield. This is in line with the findings of Afutu E, et al. [5] who reported that scab disease attacks both above and below ground parts of the cowpea plant. Mbong GA, et al. [13] also reported that the severity of scab disease increased with plant age. This means that as the scab severity and area under disease progress curve of the disease increases, the grain yield decreased significantly due to the significant negative effects of scab disease on both the morphological and reproductive growth of cowpea plants [33]. Fivawo NC, et al. [34] also reported negative correlation between Alternaria Leaf Spot of beans and grain yield and other agronomic traits. Scab severity showed a strong significant and positive correlation with area under disease progress curve, suggesting that the area under disease progress curve increased with increase in scab severity. Previous studies have also found a positive correlation between disease incidence and disease severity [35]. This was expected since scab is a polycyclic epidemic disease and thus, as long as there is fresh new leaf tissues to be infected, the severity of polycyclic diseases will increase hence increasing the area under disease progress curve [36]. The pod length had a strong significant and positive correlation with the number of seeds per pod. The longer the pod, the more the number of seeds in the pod. This is in line with the findings of Asio MT [37], who reported that pod length significantly contributed to the number of seeds per pod and was considered during selection of high yielding cowpea genotypes. Days to 50% flowering had a significant and positive correlation with days to 75% maturity. Brill R [38], who worked on wheat, reported a linear relationship between days to 50% flowering and days to 75% physiological maturity. Due to this, earlier flowering varieties mature early and so late maturing varieties. Similarly, Monpara BA, et al. [39] explained that grain yield increased steadily with the increase in earliness.

Conclusion

The study was conducted to identify cowpea genotypes with resistance against scab disease and farmer preferred traits. The study reveals that there exists resistance to cowpea scab disease among the genotypes of Taef–14–inhaca.E, 1195K–1093–5–A, TVU-2968, and SanZi having the highest resistance while TVU-9506-A, UCR-162-A, and TVU-4711 showed the lowest resistance. The mean grain yield was highest in genotypes; TVU-1280. This study recommends that cowpea genotypes; 1195K–1093–5–A, TVU–2968, TVU-–15114, SanZi, and Taef–14–inhaca.E could be used as breeding lines for introgressing scab resistance into cultivars with farmer preferred traits.

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Conflict of Interests

Authors have declared there is no conflict of interest.

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