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Identification of Blast Resistant Genotypes among Drought Tolerant Finger Millet in Uganda

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Broad-Spectrum Resistance,
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Finger millet is an important food security crop among many subsistence farmers living in marginal and especially semi-arid regions of Eastern Africa. However, crop production is affected mainly by terminal drought and blast disease caused by fungus *Pyricularia grisea*. Both collectively lead to over 90% grain yield loss depending on environmental conditions, cropping systems and varietal differences. Therefore, resistance breakdown remains high owing to variability in the blast pathogen and weather conditions. Stable varieties should possess both blast resistance and drought. In order to initiate breeding for multiple resistance to blast on drought-tolerant background, a study was conducted to identify variability for blast resistance from adapted germplasm as an initial step in developing a breeding strategy for incorporating resistance. Thirty genotypes from drought-prone agro-ecologies and including mini core germplasm from NARO-NaSARRI national Finger Millet improvement programme were assessed. They were screened using a local virulent pathogen isolate (NGR₁) from Ngora, representing Teso major farming system and is a hot spot for the blast. The screening was under controlled conditions from in Makerere University Agricultural Research Institute (MUARIK) in 2012b. The results showed significance ($p < 0.01$) for Area Under Disease Progressive Curve (AUDPC). Subsequently, the study identified IE927, Seremi1, Seremi3, Sec220 and Kabale as highly resistant to foliar blast infection comparable to Gulu-E a standard broad-spectrum resistant check and they could be used to

improve finger millet for blast resistance. Meanwhile DR33, IE9 and IE2576 as most susceptible compared to non-race -specific susceptible check E11 from Uganda.

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INTRODUCTION

Finger millet also is known as *Eleusine coracana* (L.) Gaertn. Subspecies *coracana* belongs to the family Poaceae (Hilu *et al.*, 1979). It is an important food security crop among many subsistence farmers living in marginal areas and especially in arid and semi-arid regions of the world. The crop has food security and nutritional security, cultural, medicinal and economic value with high industrial potential. It represents the second most important cereal crop in Uganda after maize and is grown on an estimated annual area of 250,000 ha producing 277,000 metric tonnes (FAO DATA, 2018.) The development, release and adoption of improved varieties contribute largely to this production. The crop is mainly produced by small-scale farmers for direct consumption as a food and a cash crop. Out of the 277,000 Metric tonnes (Mt) of finger millet

produced during the during 2008, the crop disposition was as follows: sold, 53,000 (19.0%); consumed, 104,000 (37.7%); stored, 93,000 (33.5%); and used for other purposes, 27,000 (9.8%). The grain has excellent storage capacity and recognised for health benefits such as anti-diabetic effects. However, the yield per acre in East Africa is continually declining at about 500 Kgs per acre (AgStat,2016).

Most finger millet varieties are routinely challenged by the devastating blast disease, caused by the fungus *Magnaporthe grisea*, which results in up to 90% yield losses in combination with other abiotic stresses (Takan *et al.*, 2012). Resistance instability remains high even among released varieties owing to specific reaction of the fungus strains to resistance conferred by mostly single genes leading to a breakdown of vertical resistance. Blast is mainly transmitted by air-borne

conidia, through overwintering in plant debris and weed plants in the surrounding fields. More than 50 other *Magnaporthe* hosts are known, including cultivated grass species and weed species (Mackill & Bonman, 1986). Virulence spectrum of the pathogen is associated with genetic diversity in *Magnaporthe oryzae* (Takan *et al.*, 2012). Therefore, deployment of host plant resistance without aware of pathogen variation within pathogen populations results in crop failure and could make it very difficult to select for horizontal resistance. However, limited information on response to blast among mini core finger millet germplasm selected for drought tolerance with good breeding potential. Therefore, the objective of the study was to identify sources of resistance that could be introgressed into susceptible preferred drought-tolerant backgrounds. This information will support breeding for multiple resistance which enhances plant fitness, thus contributing to high yielding resilient varieties.

MATERIALS AND METHODS

Survey

A survey was carried out using non-representative sampling in three districts of

eastern Uganda to study disease prevalence in major finger millet growing areas during the second rains (2011b), on the basis of previous work (Adipala & Wandera, 2001). Ten infected plant parts were collected from Kachumbala in fields mapped with GP with co-ordinates 36.623028E, 01.36489N at about 1172 metres above sea level. For Tororo district, ten samples were collected from Magola sub-county in fields located at GPS 36.618007E, 00.65710N at an altitude of 1092 metres above sea level. The above sites are distinct agro-ecologies around the slopes of Mount Elgon, representing cool and wet areas where the most aggressive pathogen isolates were obtained on the basis of previous work (Adipala & Wandera, 2001). The third site was Ngora district that represents hotter environments, and ten samples were picked from Odwarat sub-county 36.587968E, 0161645N at 1106 metres above sea level. Disease severity was on average 30-50% measured on two-point scale 1 = Slight infection (Auxiliary leaves), 2 = moderate to severe infection (of green panicle or severe leaf symptoms). Disease reaction was given in terms of disease index (DI), where

$$DI = \frac{(Incidence \times Average \ severity)}{2}$$

Table 1: List of drought-tolerant genotypes for artificial screening against Pyricularia

	Genotype	Pedigree	Origin	Description under natural infection
1	Pese 1	P224	Com. Variety	Resistant to head blast
2	Seremi 1	P249	Com. Variety	Resistant to foliar and head blast
3	Seremi 2	U 15	Com. Variety	Susceptible to foliar blast
4	Seremi 3	S x17-88	Com. Variety	Resistant to head and leaf blast
5	Serere 14	Serere 14	Breeder's stock	Resistant to head and leaf blast
6	Sec 20	Sec 20	Breeder stock	Resistant to head blast
7	Sec 21	Sec 21	Breeder's stock	Resistant to head and leaf blast
8	Sec 97	Sec 97	Breeder's stock	Resistant to head and leaf blast
9	Sec 220	Sec 220	Breeder stock	Resistant to head and leaf blast
10	Sec 659	Sec 659	Breeder's stock	Resistant to head and leaf blast
11	DR 21	DR 21	Malawi	Resistant to leaf blast
12	DR 32	DR 32	Malawi	Resistant to head blast

	Genotype	Pedigree	Origin	Description under natural infection
13	DR 33	DR 33	Malawi	Resistant to head blast
14	DR 8	DR 8	Malawi	Resistant to leaf blast
15	DR 62	DR 62	Malawi	Resistant to leaf blast
16	DR 43	DR 43	Malawi	Resistant to foliar and head blast
17	E11	E11	Uganda	Susceptible to all forms of blast (Susceptible check)
18	KAT FM1	KAT FM1	Kenya	Susceptible to foliar blast
19	Gulu-E	Gulu-E	Landrace	Resistant check to all forms
20	Engeny	Engeny	Landrace	Resistant to head blast head
21	Kabale	Kabale	Landrace	Resistant to head blast
22	Emiroit	Emiroit	Landrace	Resistant to head blast
23	Okiring	Okiring	Landrace	Resistant to head blast
24	IE 4545	IE 4545	India eleusine	Resistant to leaf blast
25	IE 927	IE 927	India eleusine	Resistant to head blast
26	I.E. 9	I.E. 9	India eleusine	Resistant to leaf blast
27	IE775	IE775	India eleusine	Resistant to head blast
28	IE 2540	IE 2540	India eleusine	Resistant to leaf blast
29	IE2790	IE2790	India eleusine	Resistant to head blast
30	IE2756	IE2756	India eleusine	Resistant to leaf blast

Source: (NaSARRI, 2012). Com. = Commercial variety

Preparation of Monoconidial Cultures and Layout of Experiments

(a) For isolate screening, the experiment was laid in a split-plot design with three pure isolates as subplots and standard finger millet resistant variety (Gulu-E) and susceptible variety (E11) as main plots. The experiment was conducted under the screen house from Makerere University Agricultural Research Institute Kabanyolo (MUARIK). Each pot had five plants and replicated three times, where data was collected from each plant and averaged per pot. The two varieties were deployed on the subplots (three isolates). Samples of infected plant plants (leaf, neck and head) were surface sterilized at 1% solution of sodium hypochlorite and rinsed in sterile distilled water for two minutes and then planted in 9 cm pyrex Petric dish. All standard protocol for pathogen isolation, inoculum preparation, adjustment of the concentration of spore suspension to 100,000 spores per ml and inoculation was according to (David *et al.*, 2008). The plants were inoculated at 35 days

after sowing, which was at 4-5 leaf stage (Ghazanfar, Habib & Sahi, 2009). High humidity was maintained by means of a polythene bag to facilitate infection and to prevent the spray from a particular isolate drifting to other blocks

(b) For screening of germplasm for reaction to blast, the pots were filled with a mixer of soil and farm-yard manure at a ratio of 3:1 and well-watered. Thirty pots made up one replication of 30 genotypes planted in 5x6 alpha lattices and replicated 3 times. One standard resistant check (Gulu-E) and one susceptible check (E11) were included in all the experiments as controls. The plants were inoculated by spraying using most virulent pathogen isolate identified from isolate screening. High humidity was maintained by means of a polythene bag to facilitate infection. The plants were inoculated at 35 days after sowing, which was at 4-5 leaf stage and booting stage (55 days) for the case of head and neck blast (Ghazanfar, Habib & Sahi, 2009). The

main parameters measured were leaf, neck and head infection.

Data Collection Based on Lesion Size, Percentage Leaf Area Affected and Head Blast Infection

Disease severity was recorded in terms of lesion size and percentage leaf area infected at two weeks interval from five days after inoculation up to physiological maturity (110 days) using 1-5 quantitative scale modified from (Ghazanfar, Habib & Sahi, 2009). For head blast infection severity ratings based on the number of fingers affected from grain filling stage up to harvest maturity. For the case of neck blast, sizes of lesions estimated from grain filling to harvest maturity using a similar

scale based on the number of lesions on the neck. The disease intensity data based on lesion size was later transferred to the area under the progressive disease curve (AUDPC). The AUDPC is average infection across time, which gives you an impression and amounts to overall stress. The entries were later grouped as highly resistant, moderately resistant, moderately susceptible and susceptible on the basis of standardized z-scores of areas under disease progress curves (McLeod, S. A. 2019). A negative z-score reveals the raw score is below the mean average and denotes resistance. The relative area under disease progressive curves or disease rating index is to quantify disease intensity over time (Mohapatra *et al.*, 2009).

Table 2: Disease rating (1-5) scale for leaf blast lesion types caused by *P. grisea*

1	Highly resistant	No symptoms or brown specks < 0.5 mm in diameter.
2	Resistant	Slightly larger brown specks 2-3 mm in diameter.
3	Moderately resistant	Round to elliptical lesions restricted up to 3 mm in diameter with necrotic grey centre
4	Moderately susceptible	Typical elliptical-shaped blast lesion restricted up to 6 mm long with the little coalescence of veins and yellow margin.
5	Susceptible	Half or more of the leaf-covered by coalescence of large lesions more than 6 cm, yellowing of leaves and leaves may be killed by coalescence of large lesions.

Modified from Ghazanfar, Habib & Sahi (2009)

Generally, plants rated 1-3 were considered resistant, while those rated 4-5 considered susceptible (Table 2 and 3). Resistance was expressed by restricting the amount of tissue

that is colonized at a single infection site or slow propagation of the virulent pathogen. The score data was used for computing percentage disease incidence (PDI) with the formula:

$$PDI = \left[\frac{\text{Sum of numerical rating}}{\text{Total number of leaves observed}} \times \text{Maximum score} \right] \times 100.$$

Highly susceptible plant genotype with above 40% disease severity. (Islam *et al.*, 2018)

Table 3: Disease severity ratings for leaf blast

Severity	Per cent Severity	Host response
1.0-1.4	0-5% of leaf area	HR
1.5-1.9	6-10% „	R
2.0-2.4	11-20% „	MR
2.5-2.9	21-30% „	S
3.0-3.5	31-40% „	HS
3.6-5.0	>40% „	ES

HR=highly resistant; S = Susceptible; HS= highly susceptible; ES= extremely susceptible; R= Resistant; MR= moderately resistant. Scale was modified from (Ghazanfar, Habib & Sahi, 2009)

3.2.5 Data Analysis

The area under the disease progress curve (AUDPC) was computed using the formula from (Campbell & Madden., 1990). The disease scores were standardized (Z-scores) by dividing with the number of days to the last assessment time, where Z-score less than zero is resistant (AUDPC-grand mean)/standard deviation. The relative area under disease progressive curve (RAUDPC), which is the proportion of the leaf area affected from a given genotype compared to the most susceptible variety, computed as $AUDPC = \sum [y_1 + y_{i+1}]/2] (t_i + 1 - t_{i+1})$, where “*t*” is time in days of each evaluation (evaluation was at the interval of two weeks after infection and was accumulated for 56 days with four data sets. “*Y*” is the disease score for the affected leaf. AUDPC was subjected to analysis of variance (ANOVA) and analysed quantitatively as the relative area under disease progressive curve (rAUDPC). Correlations of patterns of disease response from the leaf, neck and the head were done using with the most resistant receiving higher ranking when the data was sorted. The repeated rank test was used when two or more genotypes tied a place in ranking as according

to in order to make an adjustment to the original spearman’s ranked correlation (Veerachamy, 2008). Correlations of the pattern of disease responses from leaf, neck and head were done using a coefficient of correlation “*r*” where $r > 0$ indicates increases of relatedness.

RESULTS

Virulent Pathogen Isolate Identified for Screening Germplasm

Analysis of variance revealed significant effects ($p < 0.05$) of isolates on standard checks Gulu-E and E11 (Table 4). The Ngora isolate (NGR₁) formed the longest lesions, therefore considered most aggressive, followed by Kachumbala (KAC₁). Overall ranking indicated that the isolates obtained from three hot spots from eastern agro-ecologies of Uganda showed variation in virulence.

Table 4: Identification of the most virulent pathogen isolates to be used for screening

Isolate	Mean infection
Tororo (TRO ₁)	1.75a
Kachumbala (KAC ₁)	2.28b
Ngora (NGR ₁)	2.67c
S.E. D	0.15
LSD	0.32
C.V	11.4%

a =; b=; c = Mean infection followed by different letter is significantly different at $\alpha=0.05$

Differences Among Germplasm for Reaction to Leaf Blast Reaction

Analysis of variance on each form of the blast was significant ($p < 0.05$) (Table 5). On the basis of standardized disease scores, accumulated AUDPC and RAUDPC; genotypes Seremi1, Seremi3, Sec659, Sec220, Kabale and Gulu-E were classified as highly resistant. Meanwhile E11, IE 4545, DR33 and Okiring were found to be being highly susceptible, because they had highest positive z- score of AUDPC above 2 and RAUDPC above 0.60 compared to standard susceptible check E11.

Table 5: Z- Scores for 30 genotypes of finger millet screened for resistance

Genotype	AUDPC	Z-score	Reaction	RAUDPC (56 days)
DR21	120.1	0.3	MR	0.57
DR32	117.1	-0.1	R	0.56
DR33	142.4	3.5	HS	0.68
DR43	116.5	-0.2	R	0.55
DR62	119.9	0.2	MR	0.57
DR8	119	0.2	MR	0.57
E11(susceptible)	142.7	3.5	HS	0.68
EGENY	120.9	0.4	MR	0.58
EMIROIT	135.4	2.5	HS	0.64
GULU-E (resistant check)	103	-2.1	HR	0.49
IE2540	119.9	0.2	MR	0.57
IE2756	124.4	0.9	MR	0.59
IE2790	142.6	3.5	HS	0.68
IE4545	116.5	-0.2	R	0.61
IE775	135.7	2.5	HS	0.65
IE9	125.7	1.1	S	0.63
IE927	90.3	-3.9	HR	0.42
KABALE	99.8	-2.6	HR	0.48
KATFM1	142.4	3.5	HS	0.67
OKIRING	133.8	2.3	HS	0.64
PESE1	114.5	-0.5	R	0.55
SEC20	104.2	-2.0	HR	0.51
SEC21	118.7	0.1	MR	0.57
SEC220	103.5	-2.1	HR	0.53

Genotype	AUDPC	Z-score	Reaction	RAUDPC (56 days)
SEC659	111	-1.0	HR	0.54
SEC97	114.1	-0.5	R	0.54
SEREMI1	99.4	-2.6	HR	0.47
SEREMI2	129.5	1.7	S	0.62
SEREMI3	99.3	-2.7	HR	0.50
SERERE14	108.9	-1.3	HR	0.54
Grand Mean AUDPC	117.9			
CV %	10.3			
LSD (P<0.001)	19.9			

Disease Reaction at Physiological Maturity

Disease responses varied from seedling through the vegetative stage up to physiological maturity (Table 6). About 20% of the genotypes screened maintained resistant reaction to all forms blast with mean score of <3.0. Other studies have reported that resistance to leaf blast is conferred by the

presence of Silicon. Such genotypes, therefore, show adaptive phenotypic expression and offer prospects for breeding blast resistance. There could be structural, biochemical, genetic or molecular interaction of the host and the pathogen that is important in the management of blast disease, that need to be identified and incorporated into breeding populations to improve efficiency in selection.

Table 6: Final Mean Blast Severity Scores at Physiological Maturity

Entry	Genotype	Leaf	Neck	Head
1	DR21	3.6	4	3.6
2	DR32	3.7	2.9	3.5
3	DR33	4	3.4	3.9
4	DR43	2.7	3.1	2.7
5	DR62	2.8	2.4	2.4
6	DR8	3.8	3	3.3
7	IE2540	3.4	3	2.9
8	IE2756	3.6	3	3.6
9	IE2790	4.2	3.3	3.9
10	IE4545	2.2	2.4	3.1
11	IE775	3.3	2.8	3
12	IE9	3.6	3.3	4.1
13	IE927	2.3	2.9	3.1
14	EGENY	2.9	2.4	3.2
15	EMIROIT	3.4	3.6	3.7
16	KABALE	3	2.5	2.7
17	OKIRING	3.4	2.7	3
18	SEC20	2.9	2.8	2.9

Entry	Genotype	Leaf	Neck	Head
19	SEC21	2.7	3	2.9
20	SEC220	2.8	1.9	2.1
21	SEC659	4	3.2	3.2
22	SEC97	2.4	2	2.8
23	SEREMI1	2.7	2.1	1.9
24	SEREMI2	3.7	3.4	3.3
25	SEREMI3	2.9	2.1	2.3
26	SERERE14	2.7	2.8	2.9
27	PESE1	2.7	3	2.8
28	SERERE1	2.7	2.8	2.9
29	GULU-E (R-check)	2.4	1.7	1.9
30	E11 (S-Check)	3.9	3.6	3.8
31	KATFM (S-check)	3.9	3.4	3.6
	LSD (0.01)	1.06	0.98	0.74
	C.V	18	19.6	18.9
	S.E. D	0,63	0.38	0.34

When mean disease responses were ranked; Gulu-E, Kabale and Sec220 were consistent in maintaining the highest ranking for the three forms of the blast (*Table 7*). Testing the significance of lack of good fit through regression of leaf blast on neck blast gave

observed $t=3.84 > 2.048$ tabulated value, at $\alpha=0.05$ was not significant. Meanwhile, correlation of leaf blast on head blast gave observed $t=5.29 > 3.84$ was significant. However, coefficients of determination (R^2) were generally not above 50 %.

Table 7: Repeated Ranks for Testing Significance of Ranked Correlations Between Forms of the blast

Genotype	Leaf blast Rank (RL)	Neck blast Rank (RN)	Head blast Rank (RH)	D ₁ (RL-RN)	D ₁ ²	D ₂ (RL-RH)	D ₂ ²	D ₃ (RN - RH)	D ₃ ²
DR21	10	25	21.5	-15	225	-11.5	132.3	3.5	12.25
DR32	10	9.5	14	0.5	0.25	-4	16	-4.5	20.25
DR33	22.5	28	28	-5.5	30.25	-5.5	30.25	0	0
DR43	16.5	26	17	-9.5	90.25	-0.5	0.25	9	81
DR62	19	17	12.5	2	4	6.5	42.25	4.5	20.25
DR8	10	22.5	19.5	-12.5	156.25	-9.5	90.25	3	9
E11	24	30	30	-6	36	-6	36	0	0
EGENY	19	22.5	9	-3.5	12.25	10	100	13.5	182.3
EMIROIT	24	19.5	25	4.5	20.25	-1	1	-5.5	30.25

Genotype	Leaf blast Rank (RL)	Neck blast Rank (RN)	Head blast Rank (RH)	D ₁ (RL- RN)	D ² ₁	D ₂ (RL- RH)	D ² ₂	D ₃ (RN - RH)	D ² ₃
GULU-E	1	4	2	-3	9	-1	1	2	4
IE2540	16.5	5.5	9	11	121	7.5	56.25	-3.5	12.25
IE2756	18	29	19.5	-11	121	-1.5	2.25	9.5	90.25
IE2790	24	17	25	7	49	-1	1	-8	64
IE4545	19	14.5	25	4.5	20.25	-6	36	-10.5	110.3
IE775	20.5	22.5	25	-2	4	-4.5	20.25	-2.5	6.25
IE9	20	14.5	29	5.5	30.25	-9	81	-14.5	210.3
IE927	6.5	19.5	17	-13	169	-10.5	110.3	2.5	6.25
KABALE	4	5.5	2	-1.5	2.25	2	4	3.5	12.25
KATFM1	22.5	27	25	-4.5	20.25	-2.5	6.25	2	4
OKIRING	19	9.5	15	9.5	90.25	4	16	-5.5	30.25
PESE1	14	22.5	9	-8.5	72.25	5	25	13.5	182.3
SEC20	2	9.5	9	-7.5	56.25	-7	49	0.5	0.25
SEC21	14	12.5	9	1.5	2.25	5	25	3.5	12.25
SEC220	2	1	2	1	1	0	0	-1	1
SEC659	8.5	12.5	17	-4	16	-8.5	72.25	-4.5	20.25
SEC97	6.5	9.5	21.5	-3	9	-15	225	-12	144
SEREMI1	8.5	3	4.5	5.5	30.25	4	16	-1.5	2.25
SEREMI2	20.5	17	12.5	3.5	12.25	8	64	4.5	20.25
SEREMI3	5	2	4.5	3	9	0.5	0.25	-2.5	6.25
SERERE1	4	14	7	6	7	49	8	64	1

Original spear man's ranked correlation $P=1-6\sum D^2/n(n^2-1)$ where $D=R_X-R_Y$

P =is rank correlation coefficient and D =is the difference between ranks. R =rank positions

Correlation coefficient between leaf blast and neck blast is $P= 0.67$,

Correlation coefficient between leaf blast and head blast is $P= 0.69$,

Correlation coefficient between neck blast and head blast is $P= 0.70$,

DISCUSSION

Virulent Isolate Identification

Isolates obtained from the three hot spots in different locations from eastern savannah agroecology of Uganda showed differences in virulence. A highly virulent isolate produced larger size of susceptible reaction types on plants in comparison to the less virulent isolates (Niangabo, 2010). He also observed

variations in pathogenicity among isolates of the fungus from different locations. However, in this study isolates from Ngora representing warmer regions seemed more aggressive with faster lesion expansion rate. This is also supported by other studies, whereby the isolates from drier areas (Soroti in particular) had faster growth but low sporulation (Adipala & Wandera, 2001). Similar findings were observed in Brazil on wheat grown under high temperature with rainfall of 15mm according to

(Urashima *et al.*, (2009). From this study, germplasm should be screened using most aggressive pathogen populations. Hence, continuous survey and monitoring the existing virulences and pathogen races in the country is very important as a way of an early warning of the breakdown of specific resistant genes of the commercial varieties.

The reaction of Germplasm to Infection

Differences in varietal reaction to the blast were also reported in Uganda with finger millet variety Gulu-E having considerable resistance (Bua & Adipala, 1995). Our results also confirm this resistance of Gulu-E to blast among genotypes screened with NGR₁ pathogen isolate. Genotypes could have differed because of the history of breeding and selection both artificially and naturally. Comparison of the reactions helped to classify finger millet germplasm into highly resistant, resistant, moderately resistant, susceptible and highly susceptible. This provides opportunities for further studies on causes of such differences and their genetic control. Disease reaction need not be of the highest order, but genotype should be able to maintain epidemic development at minimum up to grain filling stage in order to minimize yield losses. A resistant variety should be able to withstand high inoculum with little disease development. They are characterized by reduced lesion size and restricted sporulation, hence prevent secondary spread during early infection cycles and such genotype should be recommended for deployment.

Relationship between Forms of Blast

There was a moderate relationship in the pattern of resistance to forms of the blast from

the consistency in high ranking among resistant genotypes and low ranking among the susceptible genotypes. A low coefficient of determination suggests that one form of the blast cannot be strongly predicted from the other and hence reduces the power for indirect selection. This observation could be a result of co-founding factors not yet known which might be structural, physiological, molecular or genetic, which needs to be determined to be incorporated into breeding progenies. Similar results were obtained from Oduori (2008).

CONCLUSION

The study, whose aim was to identify sources genetic resistance for improving drought-tolerant finger millet, was approached through identifying the most virulent pathogen isolate for screening thirty selected breeder's material. NGR₁ pathogen isolate represents the most aggressive population that could be existing in the area. It is, therefore, the most desirable isolate for screening genotypes for broad resistance, however, whether the variability indicates the considerable presence of different biotypes (races) is still unclear since this was not studied on race identification. These need to be ascertained periodically since *Pyricularia grisea* is a highly variable pathogen with wide host range. Finger millet genotypes: IE927, Kabale, Gulu-E Seremi1 and Seremi 3 are resistantly expressed as a reduction in lesion number and relative area under disease progressive curve (RAUDPC). Meanwhile, Sec21 and DR21 are fairly resistant and E11, DR33 and IE2790 were categorized as are very susceptible because they registered the highest number of lesions. Morphological structures such as leaf and neck thickness and biochemical compounds such as levels tannin

might need to be explored together with diversity for blast resistance among landrace varieties exploited.

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