



Reactions of Finger Millet (*Eleusine coracana* (L.) Gaertn) Genotypes for Blast Resistance and Yield in Wukari and Takum Taraba State, Nigeria

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Abstract:

Finger millet contains high level of methionine, tryptophan, vitamin B, fibre and minerals such as phosphorus, iron, calcium, which serve a good source of balance diet formulations for hypertension, obesity, diabetic patients, pregnant women, nursing mothers, children, people leaving with HIV, malnourished people, incidence of iron deficiency (anemia), and calcium deficiency causing rickets in young children. Production constraints responsible for the low yields have been identified as pests, blast and *Striga*, drought, low soil fertility, labor intensity, high weed infestation, low yielding varieties, lodging, and poor attitude to the crop. Finger millet blast about 50% yield

losses. This disease has been identified as the highest priority constraint to finger millet production in Nigeria, since most landraces and a number of other genotypes are highly susceptible. Field trials were conducted on 22 germplasm (U 15, P224, ACC 32, ACC14, KNE814, IE 3779, KNE 628, KNE 688, KNE 1149, Etiyo Brown, Gulu E, Kala, RW 127(IE 6613), KNE 392, GBK 029681, ACC 3953, GBK 011136A, KNE 689, KNE 1034, Emiroit, Red local check and Black local check) from ICRISAT and farmers in 3 replicates at Wukari and Takum in 2019, to assess for blast disease resistance and yield. A significant negative correlation (0.52) was found between blast severity and DF (days to flowering) suggesting that late/medium flowering varieties are more resistant than the early ones as indicated by genotypes KNE814, IE 3779, KNE 628, KNE 688, KNE 1149, Gulu E., KNE 392, GBK 029681, ACC 3953, GBK 011136A, KNE 689, KNE 1034, Emiroit and Red (local check) varieties, which were medium maturing and highly resistance to blast disease, with foliar blast severity (1.07 - 3.0), neck blast (1.5 - 2.5) and finger blast (11 - 25 %), NET (3.45 - 4.38), NFPH (5.80) and subsequently highest yield (1565 - 1887 kg/ha), compared to black local variety with the highest foliar blast severity (4.00 - 6.70), neck blast (2.7 - 4.40), finger blast (32 - 36 %), NET (2.50 - 2.70), NFPH (3.30 - 4.70) and lowest yield (688 - 989 kg/ha), respectively in Wukari and Takum locations. Hence, these varieties resistant to foliar, neck, finger blast diseases, good yield parameters are recommended as sources of germplasm for genetic improvement and further research.

Keywords: Reactions, Finger millet, Genotypes, Blast disease, Yield, Nutritional qualities.



Introduction

Finger millet (*Eleusine coracana* subsp. *coracana* $2n=4x=36$) belongs to the family *Poaceae*, subfamily *Chloridoideae* and is one of the neglected and underutilized crops of Africa. It is extensively cultivated in the tropical and sub-tropical regions of Africa and India and is known to save the lives of poor farmers from starvation at times of extreme drought (Kotschi, 2006). Finger millet ranks third in cereal production in semi-arid regions of the world after sorghum and pearl millet (Barbeau & Hilu, 1993). It is indigenous to eastern Africa, where the oldest domesticated example of this crop was found in a prehistoric site at Axum, Ethiopia, dating back some 5000 years (Hilu et al., 1979). Moreover, vast genetic diversity exists in this center of origin of Ethiopia and Uganda that has not been exploited to its full potential. In parts of eastern and southern Africa as well as in India, it became a staple upon which millions depend for food and rural household incomes. Its annual world production is at least 4.5 million tons of grain, of which Africa produces more than 2 million tons (Anon. 1996). Finger millet is adapted to a wide range of environments. The crop is grown mainly by subsistence farmers and serves as a food security crop because of its high nutritional value and excellent storage qualities (Dida et al., 2007). Most of the farmers in the savannas of Nigeria cultivate local varieties of millets (*Pennisetum glaucum* L.), sorghum (*Sorghum bicolor* L.) and groundnut (*Arachis hypogea* L.) in various intercropping systems with little or no purchased inputs and therefore yields are low (Shinggu et al., 2016) due to biotic and abiotic factors. Therefore, crop production in Nigeria is still based on traditional intercropping systems which may be quite diverse and complex (Shinggu et al., 2016). In the savanna zones of Nigeria, these systems involve intercropping of sorghum, millet, cowpea, and groundnut in various spatial and temporal arrangements and have evolved over centuries of experience to ensure maximum use of rainfall and available resources for sustainable production of food and fodder. Therefore, researchers need to also look at the cropping system approach by

intercropping finger millet and major crop like sorghum rather than only on one single crop for sustainable production.

The crop contains nutritionally important starch fractions which are slowly digested and absorbed and are favourable in the diet pattern for metabolic disorders such as diabetes, hypertension, and obesity (Vanderjagt et al., 2001). The crop was reported to have high levels of methionine, tryptophan, vitamin B, fibres and minerals such as phosphorus, iron with its calcium level 40 times more than that found in maize (*Zea mays* (L.)) and rice (*Oryza sativa* (L.)), 10 times more than that found in wheat (*Triticum aestivum* (L.)) (Thacher et al., 2000; Vanderjagt et al., 2007). This makes the crop a good source of balanced diet formulations for diabetic patients, pregnant women, nursing mothers and children. It is also recognized as an important dietary supplement for HIV positive people and help sustaining malnourished people. The high level of iron and calcium content of finger millet has been found to be relevant to populations inhabiting northern Nigeria where the incidence of iron deficiency causes anemia particularly in pregnant women (Vanderjagt, 2007) and calcium deficiency causes rickets in young children (Vanderjagt, 2001; Thacher et al., 2000). The ability of the crop to grow in water-deficit regions, the long storability of the seed for consumption and planting estimated to be at least ten years, the resistance of the grain against mould and insects make it a viable emergency food as it fits well in farmers' risk avoidance strategies in drought-prone areas (Holt, 2000). Among the tropical cereals, finger millet provides the best quality malt for local brewing and is more preferred than maize or sorghum. The malt has good taste, easily digested, rich in amino acids and is an ideal base food for people of all age categories. (Anon., 1996). Finger millet straw is also a valuable livestock feed. It makes good fodder and contains up to 61% of total digestible nutrients better than pearl millet (*Pennisetum americana*), wheat (*Triticum aestivum* (L.)) or sorghum (*Sorghum bicolor* (L.) Moench). (Anon. 1996; Upadhyaya et al. 2006). The by-product from brewery has been reported to be a

good source of fiber, mineral and protein used especially in household poultry feeding and suitable for breeding stock. (Obilana and Manyasa, 2002). The head (panicle) consists of a group of digitally arranged spikes hence the name finger millet. The spikelets are made up of 4 – 10 florets arranged serially on the finger. All florets are perfect flowers with the exception of the terminal ones which may sometimes be infertile.

Despite its importance as a low input crop, its productivity in the region is limited to between 400 and 2,000 kg/ha (Dida et al., 2007). It is estimated that finger millet accounts for some 10% of the 30 million tons of millet produced globally. Its yield potential for the crop is in the range of 4 to 5 tons ha⁻¹ but yields vary greatly depending on the place of origin of the cultivar (Dida et al., 2008). Recently, there has been a steady decline in yields in some areas in Africa where finger millet is grown. However, in India and Nepal, finger millet yields are on the increase. In India, yields are 1 ton ha⁻¹ in dry land sites and an average of 2 tons ha⁻¹ under irrigation. In East African countries, yields as low as 0.3 tons ha⁻¹ (Zimbabwe), 0.4 tons ha⁻¹ (Kenya), to as high as 1.6 tons ha⁻¹ (Uganda) have been recorded (Dida et al., 2008). In West Africa (Nigeria), finger millet yields range between 0.6 to 0.8 tons ha⁻¹ (Shinggu et al., 2009). There is evidence that finger millet production has been on a declining trend over the years. Production constraints responsible for the low yields have been identified as pests and diseases (blast and *Striga*), drought, low soil fertility, labor intensity, high weed infestation, low yielding varieties, lodging, and poor attitude to the crop (Shinggu et al., 2016). Finger millet blast disease incited by *Magnaporthe grisea* (anamorph *Pyricularia grisea*) is known to cause as much as 50% losses in yields (Sastri, 1989). This disease has been identified as the highest priority constraint to finger millet production in Nigeria, since most landraces and a number of other genotypes are highly susceptible (Mgonja et al., 2007). Moreover, finger millet is often cultivated in semi-arid and arid agro-ecology, where it is frequently affected by drought. Hence, field trials were conducted to screen Finger Millet germplasms collected from

ICRISAT and landraces from farmers for blast disease tolerance in Wukari and Takum, Taraba State

Materials and Methods

Experiment Sites

The experiments was a one year field experiment conducted in 2018/2019 at two locations namely: Teaching and Research Farm, Federal University Wukari (FUW) in Southern Guinea Savanna (SGS) (Latitude 7°51'N and 7.85°N, and longitude 9°47'E and 9.78°E) (Tunwari, 2016). It has elevation of 189 m above sea level, mean annual rainfall of 750-1205 mm and the mean annual temperature of 28 °C (Tunwari, 2016). The second location was at Taraba ADP Zonal Office Takum LGA, at Takum Taraba State in the Derived Savanna (DS) agro-ecological Zone (Latitude 07°26'N and Longitude 10° 04'E) with topography of 253 m above sea level. It has an annual average rainfall of 800-1600 mm and annual average temperature of 27 to 29 °C with vegetation similar to that of Derived Savanna (D.S.). Rains Commence as from April/ March and terminates in October/Mid -November for SGS and DS respectively, while the dry season begins from November to March in both locations (Tunwari, 2016).

Field Layout and Experimental Design

The field experiment in FUW Wukari (Latitude 07°77'N - 07°82'N and Longitude 09°83'E - 09° 87'E) and Takum (Latitude 07°26'N and Longitude 10° 04'E) were laid out using Randomized Complete Block Design (RCBD) with 20 genotypes from ICRISAT Kenya and 2 local varieties sourced from LCRI and ADPs Plateau/Kaduna totaling up to 22 treatments. These treatments (U 15, P224, ACC 32, ACC14, KNE814, IE 3779, KNE 628, KNE 688, KNE 1149, Etiyo Brown, Gulu E, Kala, RW 127(IE 6613), KNE 392, GBK 029681, ACC 3953, GBK 011136A, KNE 689, KNE 1034, Emiroit, Red local check and Black local check) were used for the two experiments in the two locations and replicated 4 times. Gross plot size was 5 m x 4 m (20m²) and net plot size will be 4m x 3m (12m²) with inter-and intra-row spacing of 75 cm and 20 cm respectively. A total of 120 plots were laid

out on the field. About six seeds sown in each planting hole and at two weeks after sowing, the emerging seedlings thinned to two plants per stand. Pre-emergence herbicide was applied at one day after sowing; supplementary weeding were done at 6 and 9. Insecticide application on stem borers and other insects was carried out accordingly. In organic fertilizer was applied at the rate of 90 kg N, 60 kg P₂O₅; 60 kg K₂O.

Data Collection

Disease Incidence Score

Leaf incidence was assessed at seedling and booting stage, neck incidence score was assessed

at harvest stage and finger blast incidence score was assessed at physiological maturity and harvest stage of plant growth. Disease incidence was recorded in percentages in the multiples of 10 (whichever is easier) from 0 to 100%. Leaf blast incidence at seedlings and booting stages were recorded by counting the number of infected plant out of the total plant population. Percentage of the result was obtained by multiplying it by 100 (Tunwari and Nahunnaro 2014)). Neck and finger blast incidences were estimated using the following formula:

$$\text{Neck blast Percent disease incidence (\%)} = \frac{\text{Number of infected neck}}{\text{Total numbers of ear heads observed}} \times 100 \quad (1)$$

$$\text{Finger blast Percent disease incidence (\%)} = \frac{\text{Number of infected finger}}{\text{Total numbers of ear heads observed} \times \text{Number of finger per head}} \times 100 \quad (2)$$

Disease Severity Assessment

Leaf blast severity

Infected leaves exhibiting uniform lesion types were photographed to make color plates to aid in the classification of disease development. The leaf blast severity was recorded at 10 randomly tagged plants per plot using a progressive 1 to 9

scale, where 1 = no lesions to small brown specks of pinhead size (0.1-1.0 mm), less than 1% leaf area affected; 2 = typical blast lesions covering 1-5% leaf area covered with lesions; 3 = 6-10%, 4 = 11-20%, 5 = 21-30%, 6 = 31-40%, 7 = 41-50%, 8 = 51-75% and many leaves dead; and 9 = typical blast lesions covering >75% leaf area or all the leaves dead (Table 1 and Figure 1).

Table 1. A Quantitative Severity Scale for Blast Disease on Finer Millet at Wukari and Takum, 2019

Leaf blast scores	Appearance of Genotypes on a 1-9 scale	Reaction Category	Leaf blast(LB) reaction based on severity on a 1 - 9 scale	Neck blast(NB) reaction based on severity on a 1 - 5 scale	Finger blast (FB) reaction based on severity (%) on a 1 - 5 scale
1	Free from any damage	Very highly resistant			
2	Less than 10% of the leaves damaged	Highly resistant (HR)	1.0 HR	0 - 1.0 HR	0 - 1.0 HR
3	11-20% of the leaves damaged	Resistant (R)	2.0-3.0 R	1.1-2.0 R	2.0-10 R
4	21-30% of the leaves damaged	Moderately resistant (MR)	11-20 MR	21-30 MR	11- 20 MR
5	31-40% of the leaves damaged	Intermediate			

6	41-50% of the leaves damaged	Moderately susceptible			
7	51-70% of the leaves damaged	Susceptible (S)	5-7.0 S	3.1-4.0 S	21-30 S
8	71-90% of the leaves damaged	Highly susceptible (HS)	7.1-9.0 HS	4.1-5.0 HS	Above 30 HS
9	More than 90% of the leaves damaged	Very highly susceptible			

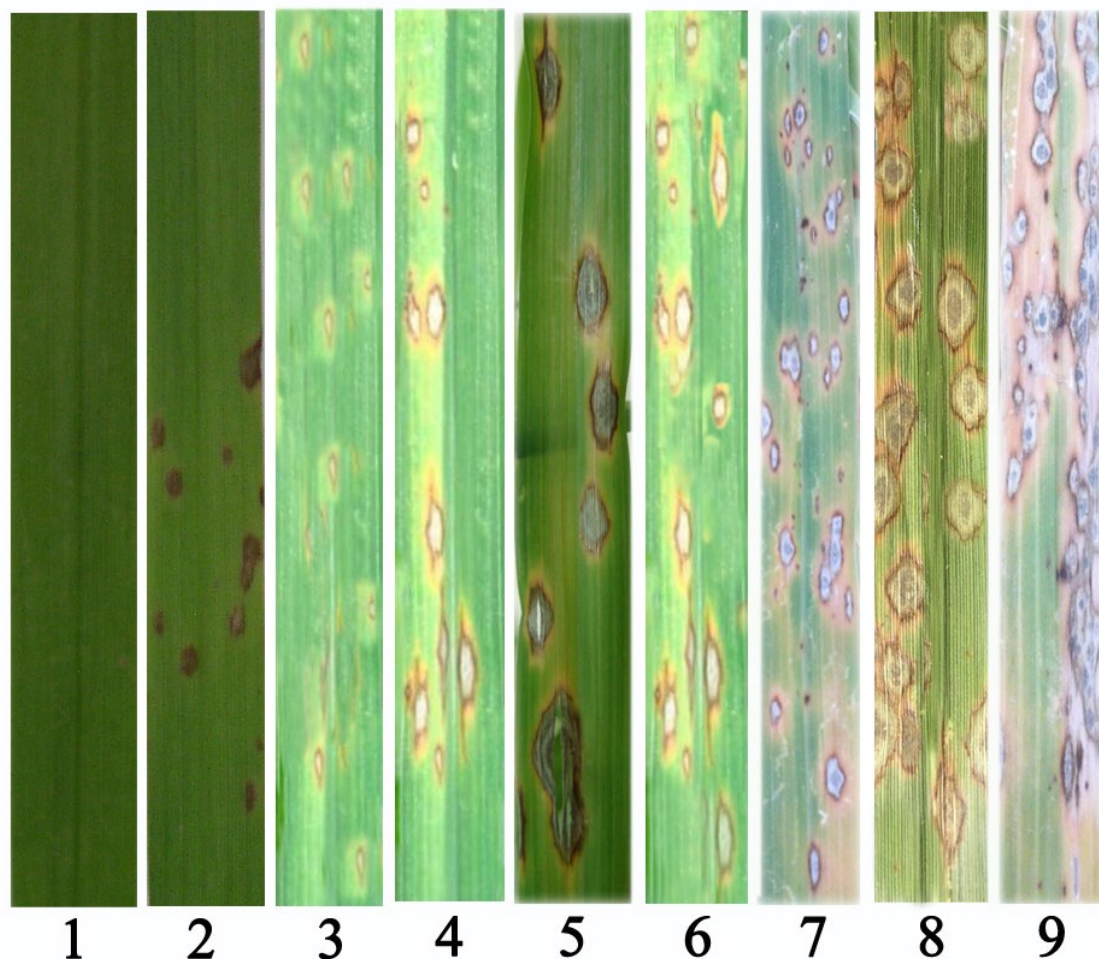


Figure 1. The 9-Class Disease Rating Scale of *Magnaporthe Grisea*

Source: Mackill and Bonman, 1992

Neck blast severity

Based on the relative lesion size on the neck a 1 to 5 progressive rating scale was developed where, 1 = no lesions to pin head size of lesions on the neck region, 2 = 0.1 to 2.0 cm size of typical blast lesion on the neck region, 3 = 2.1 to 4.0 cm, 4 = 4.1 to 6.0 cm, and 5 = >6.0 cm size of typical blast lesion on the neck region (Table 1 and Figure 2). Data were recorded in field at

the physiological maturity on 10 randomly selected individual plants of each plot.

Finger blast severity

The finger blast severity estimate was recorded as visual percentage of blasted florets across all tillers of a plant (Table 1 and Figure 3) on the same 10 randomly selected plants that were earlier rated for the neck blast severity in each row.



Figure 2. A 1–5 Rating Scale Based on Lesion Size on Neck Region for Recording Neck Blast Severity
Source: Mackill and Bonman, 1992

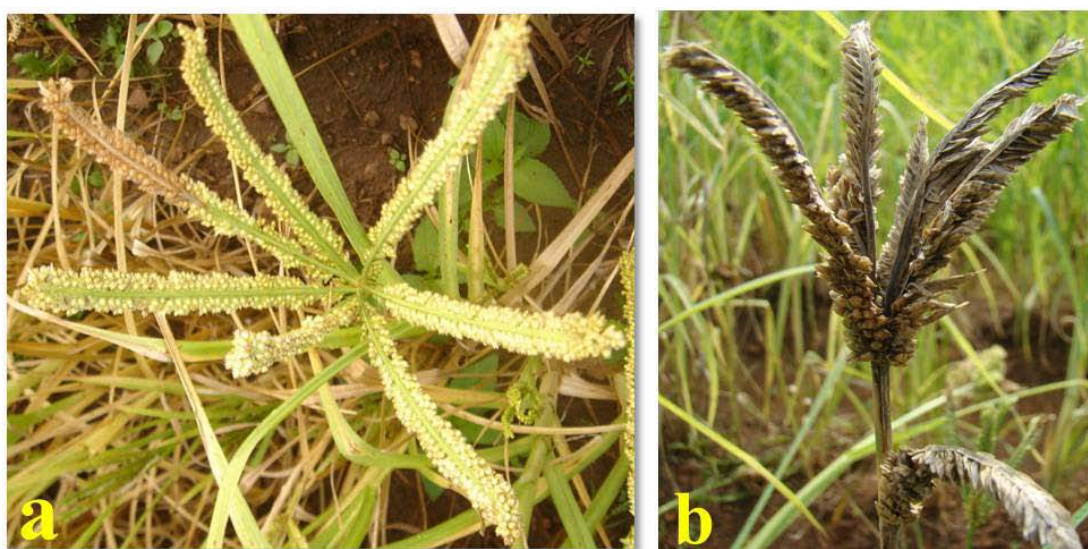


Figure 3. The Per Cent Finger Blast Severity for Finger Millet Plants Infected with *M. Grisea*. (a). Out of 7 Fingers, only Half of the Portion of Finger is Infected so, the Per Cent Finger Blast Severity is 7% (b). Photograph Showing 100 % Severity of Infection

Agronomic Traits

Data were also recorded for agronomic traits, such as days to flowering (DF) (time of full panicle emergence in 50% of the plants in a row) and plant height (measured from the base of the plant to the tip of the panicle at maturity).

Number of Effective Tillers per Plant (NET)

The numbers of tillers were determined based on ten random plants of each net plot.

Number of Fingers per Head (NFPH)

Finger number per plant was determined by counting fingers of the ten randomly taken plants and determining average per plant.

Grain Yield (tons ha⁻¹)

Measured as grain mass was taken from the 40 plants, post harvested and converted to tons ha⁻¹ using the formula:

$$\text{Grain yield (tons ha}^{-1}\text{)} = \frac{333,333 \times \text{yield of the 40 plants (kg)}}{40 \times 1000} \quad (3)$$

Data Analysis

Data collected from field experiments were subjected to analysis of variance (ANOVA) for RCBD using the generalized linear model (GLM) procedure of SAS Version 9.1 (SAS, 2005). Treatment means separation was carried out with the Duncan's Multiple Range test (DMRT) according to Gomez and Gomez (1984) at 5 % level of significance. The magnitude and type of relationship between the various parameters (emergence count, plant height, leaf area, number of tillers, days to 50% heading, days to physiological maturity, days to full maturity, productive and unproductive tillers, panicle weight per plant, number of fingers per plant, panicle length per plant, 1000 grain yield, grain yield, straw yield, harvest index, incidence and severity) were determined by

simple correlation analysis (Little & Hills, 1978).

Results and Discussion

Identification

Leaf blast appears on leaves as small brown spots. Typical lesions are elliptical or diamond-shaped, with grey centers, water soaked and surrounded by a chlorotic halo (Figure 4). Neck blast is characterized by the appearance of brown lesions in the neck region. Lesions later girdle the neck. As the disease progresses, the affected portion may rot or dry out causing spikelet sterility. Finger blast appears as a discolouration of the fingers that dry prematurely to various degrees. The infected fingers may be shriveled with sterile grains depending on the time of infection.



Figure 4. Leaf Blast Lesion Showing Brown Colouration with Grayish Centres

Foliar Blast Severity at Booting Stage of Selected Finger Millet Genotypes at Wukari and Takum Locations in 2019

The findings showed significant genotypic variation for disease severity ($p \leq 0.05$) (Table 2). Finger millet varieties U 15, ACC14, P224 and ACC 32 exhibited highest leaf blast severity at booting stage (4.35 to 6.73), compared to KNE814, IE 3779, KNE 628, KNE 688, KNE 1149, Gulu E., KNE 392, GBK 029681, ACC 3953, GBK 011136A, KNE 689, KNE 1034, Emiroit and Red (local check) with the lowest mean severity of 1.70 to 3.07 in both Wukari and Takum locations. Severity rating in Table 1 indicated that leaf blast severity on a 1-9 scale with 2-3 scores are in the resistant (R) category, while those with scores of 4-7 are in the susceptible (S) category. Disease severity was generally observed to be more in Takum than Wukari locations, and this could be attributable to the fact that Takum is in derived savanna ecology with more rainfall and relative humidity than Wukari in the southern guinea savanna. The predominant symptoms of blast disease in any given area depend upon the climatic conditions. According to Ou (1987) where there are long periods of drizzle or light rains, leaf blast at tillering stage is often severe and may kill the plants completely. Estimated yield losses due to leaf blast have been attempted. Leaf blast causes stunting of plants, and reduces the number of matured panicles, the 100 grain weight and the weight of grains (Ou, 1987). Conidia are normally produced on lesions about 6 days after inoculation or spore landing on host plant. The rate of sporulation increases with increase in relative humidity; below 93 % RH no conidia are produced (Tunwari and Nahunnaro 2014). A typical lesion is able to produce 2000 – 6000 conidia each day for about 14 days under laboratory conditions (Ou, 1987). Kato et al. (1970) reported that conidial formation reaches a peak 3-8 days after the appearance of lesions and 10-20 days after the appearance of lesions on rachis.

Reaction of Finger Millet Genotypes on neck blast and finger blast severity at Wukari and Takum, Taraba State

Reactions of 22 finger millet genotypes on neck and finger blast severity at physiological maturity are presented in Table 2. The results presented highly significant highest neck blast and finger blast severity within and between locations on genotypes. U 15, P224, Gulue E, ACC 32 and Black local gave highly significant more neck blast severity (2.7 - 4.40) and finger blast severity (32 -36) at physiological maturity, compared to KNE814, KNE 688, KNE 1149, Etiyo Brown, KNE 392, ACC 3953, KNE 1034, Emiroit and Red (local check) varieties with the lowest neck blast severity (1.5 - 2.5) and finger blast severity (11.50 - 25.00) respectively. All the varieties had a low blast reaction with blast scores of < 3.0 for leaf, neck, finger, and overall blast. The results confirmed the works by Mgonja et al., 2007 in Tesso district of Kenya that, varieties KNE688, KNE814 and KNE1149 had the lowest blast incidences of <2.0, while Acc.32 was the earliest to flower (68 days) but also had the highest blast incidence scores of 3.0. This reflects the susceptibility of early maturing varieties, as reported in previous finger blast screening research (Pande et al., 1995). Blast caused by *Magnaporthe grisea* (anamorph *Pyricularia grisea*) has been identified as one the highest priority constraints to finger millet production. Blast affects finger millet at all stages of growth and most of the landraces and a number of other genotypes are highly susceptible. Certain forms of blast can cause failure of the grain to set and seeds to shrivel resulting in major yield losses (Mgonja et al., 2007).

There is a negative correlations between foliar and panicle blast severity and plant height indicating that tall and late maturing varieties might escape blast infection. A significant negative correlation (0.52) was found between blast severity and DF (days to flowering) suggesting that late flowering varieties are more resistant than the early ones as indicated by genotypes KNE814, KNE 688, KNE 1149, Etiyo Brown, KNE 392, ACC 3953, KNE 1034,

Emiroit and Red (local check) varieties which were medium maturing and highly resistance to blast disease. Significant positive correlation between neck and finger blast incidence has earlier been reported in finger millet (Wekesa et al., 2019). Foliar blast occurred in a majority of accessions at the seedling stage, which did not correlate well with crop growth stages and maturity of the plants, probably because of the buildup of adult plant resistance. Significant moderate correlations between leaf blast with neck and, finger blast suggest that a high level of leaf blast severity may not result in severe neck or finger blast during the later stages of plant development. Poor correlation has been observed for leaf blast with neck blast ($r = 0.04$) and finger blast ($r = 0.27$) infection (Wekesa et al., 2019) on in finger millet. It has been reported that seedlings of finger millet are more susceptible to leaf blast than mature plant (Wekesa et al., 2019). However, no relationship is known between the intensity of seedling infection and that of later neck and finger infection. Rather prevailing weather conditions at a particular stage of crop development determine the intensity of blast infection (Wekesa et al., 2019). Contrasting responses between the vegetative stage and reproductive stage often occur indicating differential gene expression for resistance to leaf, neck and/or finger blast infection. This shows that resistance to finger blast may be in some finger millet

genotypes independent from resistance to leaf blast. The results agree with findings of earlier studies (Wekesa et al., 2019). In rice similar results were reported in rice (Wekesa et al., 2019). In contrast, finger blast severity did not correlate well with agronomic parameters measured probably because of the build-up of adult plant resistance. The negative correlations between plant height and foliar severity, neck severity and finger severity indicate that tall varieties might escape blast infection due to less favorable microclimatic conditions (Wekesa et al., 2019). A significant negative correlation was found between blast severity and days to flowering suggesting that early flowering accessions are more susceptible than the late ones (Wekesa et al., 2019). This reflects the susceptibility of early maturing varieties. From the weather data collected from two locations it shows that Takum was warmer and humid compared to Wukari, hence the reason for more disease development in this site. There was however, a weak positive correlation between foliar blast severity and neck blast severity (0.021). Similarly, panicle blast severity (0.0009) did not correlate well with agronomic parameters measured, probably because of the build-up of adult plant resistance. Hence, neck and panicle blast reactions that are more destructive than leaf blast were considered important parameters for blast resistance.

Table 2. Finger Millet Genotypes Evaluated for Blast Resistance at Wukari and Takum, Taraba State in 2019

S/N	Accessions	Leaf Blast Severity at Booting Stage		Neck Blast Severity at physiological maturity		Finger Blast Severity at physiological maturity	
		Wukari	Takum	Wukari	Takum	Wukari	Takum
1.	U 15	5.20 ^a	5.60 ^b	4.20 ^a	4.40 ^a	32.00 ^a	34.33 ^{abc}
2.	P 224	5.10 ^b	5.73 ^b	2.83 ^d	3.60 ^c	33.67 ^{ab}	36.03 ^{ab}
3.	ACC 32	4.35 ^c	5.60 ^b	3.23 ^c	3.77 ^{bc}	21.33 ^{cde}	23.50 ^{defg}
4.	ACC 14	5.60 ^a	6.73 ^a	2.50 ^f	2.83 ^e	18.00 ^{defg}	20.33 ^{efgh}
5.	KNE 814	2.13 ^{gh}	2.53 ^h	1.53 ^{ij}	1.85 ^{hi}	21.33 ^{cde}	24.33 ^{defg}
6.	I E 3779	2.07 ^g	2.63 ^g	2.72 ^{de}	3.23 ^d	23.33 ^{cd}	26.57 ^{def}
7.	KNE 628	2.50 ^{gh}	2.87 ^{fg}	2.60 ^{ef}	2.87 ^e	26.00 ^{bc}	27.27 ^{cde}
8.	KNE 688	2.50 ^{gh}	3.00 ^f	1.70 ^{hi}	2.03 ^{gh}	18.00 ^{defg}	19.17 ^{fgh}
9.	KNE 1149	2.30 ^h	2.63 ^g	1.70 ^{hi}	1.93 ^{hi}	21.00 ^{cde}	23.53 ^{defg}
10.	Etiyo Brown	3.53 ^d	3.70 ^e	1.57 ⁱ	1.85 ^{hi}	22.10 ^{cde}	23.50 ^{defg}
11.	Gulu E	2.70 ^{fg}	2.87 ^{fg}	2.67 ^{de}	3.00 ^e	35.00 ^a	38.10 ^a
12.	Kala	3.60 ^d	4.20 ^d	2.72 ^{de}	2.87 ^e	18.33 ^{defg}	19.13 ^{fgh}
13.	RW127	3.70 ^d	3.80 ^e	2.30 ^g	2.50 ^f	17.00 ^{defg}	18.27 ^{gh}

14.	KNE 392	3.07 ^e	3.07 ^f	1.50 ⁱ	1.78 ⁱ	22.00 ^{cde}	22.90 ^{defg}
15.	GBK 029681	2.53 ^g	2.76 ^{fg}	1.79 ^{hi}	2.43 ^f	27.00 ^{bc}	29.13 ^{bc}
16.	ACC 3953	2.70 ^{fg}	3.03 ^f	1.45 ⁱ	1.68 ^j	23.00 ^{cde}	25.50 ^{defg}
17.	GBK 011136A	2.82 ^f	2.91 ^{fg}	1.62 ^{hi}	1.87 ^{hi}	25.33 ^c	27.32 ^{cde}
18.	KNE 689	5.17 ^b	5.54 ^b	3.50 ^b	3.77 ^{bc}	12.93 ^{fg}	14.10 ^h
19.	KNE1034	2.80 ^f	2.90 ^{fg}	1.70 ^{hi}	1.85 ^{hi}	12.83 ^{fg}	15.13 ^h
20.	Emiroit	2.77 ^f	3.07 ^f	1.70 ^{hi}	2.17 ^g	16.17 ^{efg}	17.83 ^{gh}
21.	Red local)	2.50 ^{gh}	2.80 ^{fg}	1.50 ⁱ	1.70 ^j	11.50 ^g	14.83 ^h
22.	Black(local)	3.70 ^d	4.80 ^c	3.60 ^b	3.83 ^b	23.00 ^{cde}	26.83 ^{def}
	Mean	3.22	3.76	2.20	2.63	21.86	23.92
	SE	0.12	0.16	0.10	0.12	3.52	4.04

Note: Means in a column follow by the same letter shows that there is no significance difference at P= 5% but when follow by different letters, there is significance difference.

Means of Yield related Traits on 22 Finger Millet Varieties at Wukari and Takum, Taraba State in 2019

As seen in Table 3, Kala, KNE814, KNE 689, KNE 1149, Etiyo Brown, KNE 1034, Emiroit and Red (local check) varieties significantly maintained the highest NET (3.45 - 4.38),

NFPH (5.80) and subsequently highest yield (1565 - 1887 kg/ha), compared to Black local, U15, KNE628 and Gulu E of 688 - 989 kg/ha⁻¹ in both locations. Finger millet is a crop with high tillering ability and this has been found to have a positive effect on crop biomass and yield (Shinggu et al., 2009). Wheat, a crop

Table 3: Means of Yield related Traits taken on the 22 Test Varieties in 2019 at Wukari and Takum, Taraba State

S/N	Accessions	Net Effective Tillers (NET)		Number of Fingers per head (NFPH)		Grain Yield in kg/ha	
		Wukari	Takum	Wukari	Takum	Wukari	Takum
1.	U 15	2.91 ^{gh}	3.18 ^{bc}	5.90 ^b	6.36 ^a	768.50 ^{fg}	773.50 ^{fg}
2.	P 224	3.42 ^{def}	3.55 ^{def}	5.42 ^{fgh}	5.42 ^{fgh}	1410.67 ^{abcdef}	1415.70 ^{abcdef}
3.	ACC 32	2.80 ^{gh}	2.84 ^{gh}	5.20 ^h	5.04 ⁱ	1323.50 ^{abcdefg}	1328.58 ^{abcdefg}
4.	ACC 14	2.57 ^h	2.64 ^h	5.48 ^{defg}	5.56 ^{efg}	1420.33 ^{abcdef}	1425.40 ^{cdefg}
5.	KNE 814	3.73 ^{cde}	3.78 ^{cde}	5.38 ^{fgh}	5.44 ^{fgh}	1048.00 ^{cdefg}	1053.20 ^{cdefg}
6.	I E 3779	3.85 ^c	3.86 ^c	5.23 ^{gh}	5.25 ^h	1565.00 ^{abcde}	1570.20 ^{abcde}
7.	KNE 628	3.74 ^{cde}	3.78 ^a	5.48 ^{defg}	5.62 ^{def}	951.67 ^{efg}	956.80 ^{efg}
8.	KNE 688	3.45 ^{cdef}	3.62 ^h	5.53 ^{cdef}	5.77 ^{bcde}	1567.17 ^{abcde}	1572.30 ^{abcde}
9.	KNE 1149	3.81 ^{cd}	3.88 ^{cd}	5.67 ^{bcde}	5.70 ^{cde}	1838.17 ^{ab}	1843.00 ^{ab}
10.	Etiyo Brown	3.18 ^{fg}	3.26 ^{fg}	5.80 ^b	5.93 ^b	1697.83 ^{abc}	1702.90 ^{abc}
11.	Gulu E	2.54 ^h	2.65 ^h	5.75 ^{bc}	5.76 ^{bcde}	688.50 ^g	693.58 ^g
12.	Kala	4.67 ^a	3.43 ^{de}	6.59 ^a	6.54 ^a	1882.83 ^a	1887.90 ^a
13.	RW127	3.64 ^{cde}	3.70 ^{cde}	5.23 ^{gh}	5.43 ^{fgh}	1177.37 ^{bcdefg}	1182.45 ^{bcdefg}
14.	KNE 392	2.83 ^{gh}	2.90 ^{gh}	5.43 ^{efgh}	5.47 ^{fgh}	1540.77 ^{abcde}	1545.90 ^{abcde}
15.	GBK 029681	3.81 ^{cd}	3.90 ^a	5.71 ^{bcd}	5.78 ^{bcde}	1127.75 ^{cdefg}	1132.80 ^{cdefg}
16.	ACC 3953	3.74 ^{cde}	3.76 ^{cde}	5.34 ^{fgh}	5.37 ^{gh}	1554.66 ^{abcde}	1559.87 ^{abcde}
17.	GBK 011136A	3.82 ^{cd}	3.85 ^{bc}	5.53 ^{cdef}	5.57 ^{defg}	1442.70 ^{abcde}	1447.90 ^{abcde}
18.	KNE 689	2.72 ^h	3.82 ^{bc}	5.75 ^{bc}	5.79 ^{bcd}	1665.97 ^{abc}	1670.80 ^{abc}
19.	KNE1034	3.17 ^{fg}	3.22 ^{fg}	5.81 ^b	5.88 ^{bc}	1642.97 ^{abcd}	1647.50 ^{abcd}
20.	Emiroit	3.35 ^{ef}	3.40 ^{ef}	5.80 ^b	5.87 ^{bc}	1860.37 ^a	1865.50 ^a
21.	Red local)	4.28 ^b	4.38 ^a	6.51 ^a	6.87 ^a	1725.35 ^{abc}	1730.50 ^{abc}
22.	Black(local)	2.70 ^h	2.43 ^h	3.320 ⁱ	4.72 ⁱ	983.30 ^{defg}	988.70 ^{defg}
	Mean	3.40	3.45	5.54	5.69	1403.79	1408.87
	SE	0.22	0.21	0.13	0.12	278.26	283.50

Note: Means in a column follow by the same letter shows that there is no significance difference at P= 5% but when follow by different letters, there is significance difference.

With similarly high tillering ability, compensated for low population densities by increased production and survival of tillers (Shinggu *al.*, 2016). The variations in the growth and yield parameters of the diseased plants could be due to differences in the reactions of the different genotypes to pathogens (Tunwari et al., 2013) and environmental factors such as soil/edaphic factors, rainfall and build up of inoculum from previous residues left in the field (Tunwari et al., 2013).

Conclusion

The result of the study has in a way provided better information on the twenty-two finger millet varieties in terms of their relative individual resistance to blast disease, adaptation to the climatic conditions prevailing, their yield potentials. There is a negative correlations between foliar and panicle blast severity and plant height indicating that tall and late maturing varieties might escape blast infection. A significant negative correlation (0.52) was found between blast severity and DF (days to flowering) suggesting that late flowering varieties are more resistant than the early ones as indicated by genotypes KNE814, KNE 688, KNE 1149, Etiyo Brown, KNE 392, ACC 3953, KNE 1034, Emiroit and Red (local check) varieties, which were medium maturing and highly resistance to blast disease, with foliar blast severity (1.07 - 3.0), neck blast (1.5 - 2.5) and finger blast (11 - 25 %), compared to the highest foliar blast severity (4.00 - 6.70), neck blast (2.7 - 4.40 and finger blast (32 - 36 %) respectively in Wukari and Takum locations. Further more, Kala, KNE814, KNE 689, KNE 1149, Etiyo Brown, KNE 1034, Emiroit and Red (local check) varieties significantly exhibited the highest NET (3.45 - 4.38), NFPH (5.80) and subsequently highest yield (1565 - 1887 kg/ha), compared to Black local, U15, KNE628 and Gulu E of 688 - 989 kg ha⁻¹ in both locations. Therefore, it can be concluded that KNE814, IE 3779, KNE 628, KNE 688, KNE 1149, Gulu E., KNE 392, GBK 029681, ACC 3953, GBK 011136A, KNE 689, KNE 1034, Emiroit and

Red (local check) which are resistant to foliar, neck, finger blast diseases, good agronomic/yield parameters, good straw weight and nutrient composition could serve as sources of germplasm for genetic improvement and as an alternative source of animal feed.

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