Evaluation of Tomato (*Solanum lycopersicum*L.) Accessions Resistance against Fusarium Wilt (*Fusarium oxysporum*).

ABSTACT

Aim: Fusarium wilt (*Fusarium oxysporum*) is one of the major biotic factors limiting tomato production globally. Research was conducted in three environments to screen and identify Nigeria tomato accessions that are resistant to fusarium wilt. **Methodology**: Twelve (12) prominent tomato accessions were collected and screened against *Fusarium oxysporum* by artificial inoculation under field conditions in three diverse environments. The experiments were laid out in a Randomized Complete Block Design with three replications. Data were collected on plant height (cm), number of leaves per plant, number of fruits per plant, and fresh fruits yield per plant (kg) and analyzed using IRRI STAR software. Disease scoring was done using a 0-9 point rating scale in the evaluation trials. **Result:** The results show some significance levels ($P<0.05$) in the traits studied within the accessions. The screening result revealed that none of the twelve prominent accessions is highly resistant to the pathogen. One accession was resistant. Three were moderately resistant; three were moderately susceptible and five were highly susceptible. **Conclusion**: The accessions that were resistant and moderately resistant could be used as a gene donor for breeding for tomato cultivars resistant to *Fusarium oxysporum*. Moreover, the accessions that have been identified to be resistant and moderately resistant with high yield should be cultivated before improved cultivars that will be resistant to *Fusarium oxysporum* will be readily available and accessible in rainforest and derived guinea savanna agro-ecological zones of Nigeria.

Keywords: *Fusarium oxysporum*; Resistance; Screen; Susceptible; Tomato.

1. INTRODUCTION

Tomato (*Solanum lycopersicum L.*) is one of the most significant vegetable crops globally. It is widely cultivated for its nutritional and economic values [1]. It can be grown in diverse agro-ecological regions throughout the year provided irrigation facilities are available. Africa's total tomato production was approximately 24 million metric tons in 2023, with Egypt, Nigeria, and Morocco being the leading producers [2]. It is rich in vitamins and minerals [3]. It also contains phytochemicals that are excellent antioxidants that can reduce the risk of heart disease [4]. Tomato fruit quality relies on the cultivar, cultural practices adopted, harvest time and method, storage, and handling procedures [5]. The fruits can be processed industrially or domestically. The crop's economic importance cannot be neglected due to its substantial contribution to food security and income for millions of farmers [6].

Despite tomato significance, its production is limited by various biotic factors, including Fusarium wilt, caused by the soil-borne pathogen *Fusarium oxysporum f. sp. lycopersici (Fol).* Fusarium wilt is one of the most significant diseases affecting tomato production globally. The incidence is more pronounced in acidic soils and tropical regions where the environment favoured it [7]. Fusarium wilt is a vascular disease that significantly impedes tomato productivity by colonizing the xylem vessels leading to leaf yellowing, stunted growth, wilting, and plant death [8]. According to Jarvis [9], economic losses due to Fusarium wilt are huge, affecting production in the field and greenhouse production systems.

Given the persistent threat posed by Fusarium wilt, the development and deployment of resistant tomato varieties are critical for the sustainable management of the disease. Resistant cultivars provide the most cost-effective and environmentally friendly means of controlling Fusarium wilt [10]. However, the effectiveness of these cultivars is often compromised by the emergence of new Fol races and pathogen variants. Therefore, continuous evaluation of tomato accessions for resistance to Fusarium wilt is essential to identify and develop cultivars that can withstand current and emerging strains of the pathogen [11]. The research aims at screening and identifying Nigeria tomato accession (s) that are resistant to Fusarium Wilt.

2. MATERIALS AND METHODS

2.1 The study locations

The experiment was conducted in three field environments; Biological Garden of the University of Medical Sciences Ondo-City, Teaching and Research Centre, Ekiti State University, Ado-Ekiti and Oke-Ako/Irele Farm Settlement, Oke-Ako Ekiti, all in Nigeria during the early cropping season of 2024 and at the Department of Crop, Horticulture and Landscape Design Laboratory, Ekiti State University, Ado-Ekiti Nigeria. Ondo and Ado-Ekiti lie in the rainforest agroecological zone, while OkeAko-Ekiti lies in the derived guinea savanna.

2.2 Experimental materials

The experimental materials used for the work comprised 12 Nigeria tomato accessions obtained in different agroecological zones of Nigeria (Table 1). The tomato accessions were named after the place of their collection for easy identification. The pathogen, *Fusarium oxysporium*was isolated from infected tomato plant stems and roots showing typical symptoms of the pathogen from the tomato field of the Teaching and Research Farm of Ekiti State University, Ado-Ekiti.

Table 1: List of 12 tomato plant accessions screened for resistance to *Fusarium oxysporium*and their place of collection.

Accession Code	Source of collection	Agro-Ecological Zone	Accession Code	Source of collection	Agro-Ecological Zone
Acc. 1	Ikole-Ekiti,	FZ	Acc. 7	Otun-Ekiti	DS
Acc. 2	Calabar	FZ	Acc. 8	Kabba	DS
Acc. 3	Okitipupa	FZ	Acc. 9	Ilorin	SGS
Acc. 4	Ilesa	FZ	Acc. 10	Lafia	SGS
Acc. 5	Akpoka	DS	Acc. 11	Zaria	NGS
Acc. 6	Oro	DS	Acc. 12	Kano	NGS

Note: NGS: Northern Guinea Savanna; SGS: Southern Guinea Savanna; DS: Derived Savanna; FZ: Forest Zone

2.3 Isolation, purification and its pathogenicity test of the *Fusaruim oxysporium*inoculum

Infected tomato plant stems and roots showing typical symptoms of *Fusarium oxysporium* were chopped into pieces with a sterilized chopper and surface sterilized with 0.1 per cent mercuric chloride for 35 seconds and washed with sterilized water. The water was drained properly and transferred into potato dextrose agar (PDA) medium in Petri dishes aseptically. 40 µgl-1 of streptomycin was added to the Petri dishes to avoid bacterial contamination before pouring the potato dextrose agar. The PDA Petri dishes were incubated for 120 hours at 28 ± 2 ºC. After three days of inoculation, radiating mycelia growth was seen at the edges of the infected bits and the edge of the fungal colonies were carefully transferred to PDA medium slants in a refrigerator at 10ºC and were periodical sub-culturing for the studies. The pathogen was identified as *Fusarium oxysporium* based on its morphological and cultural characteristics [12-13]. The pathogenicity of the isolates was established using Koch's postulates. The agar slants and Petri plates containing *Fusarium oxysporium* inoculums were stored according to Harlapur*et al.* [14].

2.4 Field Experimental design and cultivation condition

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replicates across three environments. The seeds of different tomato accessions across different agroecological zones of Nigeria were nursed at the standard nursery of Ekiti State University Teaching and Research Farm, Ado-Ekiti and transported to different experimented sites for transplanting. The seedlings were transplanted on a well-prepared plot at 18:00 of the day. Each of the accessions was raised in 8 m2 plots. Good agronomic practices were adopted to obtain perfect plants.

2.5 Inoculum preparation and inoculation

The isolated and purified *Fusarium oxysporium*inoculum stored at 50C was re-cultured in a PDA medium. Miura et al [15] procedure was adopted in the preparation of conidial suspension. Tween 20 was added to

gelatin (0.02% Tween 20 in 0.25% gelatin) to the prepared suspension to enhance a proper adherence of conidia to the tomato aerial parts [16]. The tomato plant was inoculated 15 days after transplanting by spraying the prepared 1 x 106 spores per ml of conidial suspension containing 0.02% Tween 20 in 0.25% gelatin per plot using a knapsack sprayer. The inoculum was sprayed around 18:00 hours of the day and ensured that the entire plant surface became wet with conidial suspension and left overnight. Water was sprayed with a knapsack sprayer on the tomato plants six times at two-hour intervals after 12 hours of inoculation.

2.6 Disease assessment, data collection and analysis

Disease scoring of the inoculated tomato plants was done 50 days after inoculation according to Challagulla et al.[17]. Data were collected plant height (cm), number of leaves per plant, number of fruits per plant and fresh fruit yield per plant (Kg). The data collected was analyzed using IRRI STAR software (18). Means were separated by Duncan's multiple range test (DMRT) (P = 0.05).

3. RESULTS AND DISCUSSION

Table 3 presents the mean values for fresh fruit yield per plant and some other yield components of twelve (12) Nigeria tomato plant accessions screened against fusarium wilt across three environments. The parameters studied in the experiment show some significant levels (P>0.05) among the twelve accessions. The level of significance indicated the extent of genetic variability among the accessions. This indicated that genetic improvement can be made within these accessions [19].The result shows that accession from Zaria (127.33) had the highest mean value for plant height, followed by Ilesa and Otun-Ekiti with 126.00 and 121.00 respectively. Okitipupa (35.00) recorded the highest value for the number of fruits per plant followed by Kabba (30.33). Vegetatively, Ilesa (72.33) had the highest number of leaves per while Kano (26.00) had the least number of leaves per plant. Zaria (1.84) had the highest fresh fruit yield per plant followed by Kabba (1.54). Accession from Otun-Ekiti and Oro dies off during the flowering stage. They couldn't produce fruits. The variances observed in these traits among twelve accessions could be attributed to different genetic make-up of the accessions [20].

Table 2: Scale for rating of disease in tomato plant

Grade	Disease severity	Host response
0	No lesion or wilt observed	Highly Resistant
1	Small brown specks of pin point size	Resistant
2	Small roundish to slightly elongated, necrotic gray spots, about 1-2 mm	Moderately

	in diameter, with a distinct brown margin. Lesions are mostly found on the lower leaves	Resistant
3	Lesion type same as in 2, but significant number of lesions on the upper leaves	Moderately Resistant
4	Typical susceptible Fusarium lesions, 3 mm or longer infecting less than 4% of leaf area	Moderately Susceptible
5	Typical susceptible Fusarium lesions of 3mm or longer infecting 4-10% of the leaf area.	Moderately Susceptible
6	Typical susceptible Fusarium lesions of 3 mm or longer infecting 11-25% of the leaf area.	Susceptible
7	Typical susceptible Fusarium lesions of 3 mm or longer infecting 26-50% of the leaf area.	Susceptible
8	Typical susceptible Fusarium lesions of 3 mm or longer infecting 51-75% of the leaf area. Many leaves are dead.	Highly Susceptible
9	Typical susceptible Fusarium lesions of 3 mm or longer infecting more than 75% leaf area affected. The plant dies-off.	Highly Susceptible

Table 4 presents the summary of tomato accessions wilt severity recorded across the three environments. The result shows that none of the accessions evaluated was highly resistant to fusarium wilt disease. Accession from Kano was resistant to fusarium wilt. Accessions from Ikole, Calabar, and Zaria were moderately resistant. Accessions from Okitipupa, Akpoka, and Kabba were moderately susceptible while accession from Ilesa, Ilorin, Lafia, Oro and Otun-Ekiti were highly susceptible. This work is in agreement with the findings of Sultan et al., [21] and Molagholizadeh et al., [22] who reported different host responses in some hybrid tomato plants to fusarium wilt. The disparity in host response to fusarium wilt within the accessions could be a result of the differences in their genetics [20]. The resistant and moderately resistant accessions identified can be exploited in a breeding programme for the development of fusarium wilt resistant for commercial cultivars. Accession from Kano recorded a poor yield but is resistant to fusarium wilt.

4. Conclusion

This work revealed that none of the tomato plant accessions grown in the prominent tomato growing areas in different parts of Nigeria were highly resistant to fusarium wilt under field artificial inoculation. Only one accession of the twelve accessions screened was found to be resistant. However, the only resistant varieties had poor fruit yield. The moderately resistant accessions could be exploited in disease resistance breeding programs using plant breeding techniques for the development of varieties Farmers are advised to grow the accessions that are moderately resistant in Southwestern Nigeria to avert fruit

yield loss due to fusarium wilt pending the time tomato cultivars that are resistance to fusarium will readily available and affordable.

Table 3: Mean performance of parameters taken from 12 Nigeria Tomato accessions screened against Fusarium wilt disease across the three environments.

Acc.	PH (cm)	NLP-1	NFP-1	FFYP-1 (kg)
Ikole-Ekiti	90.00^{ab}	53.67^{abc}	24.00^{abc}	1.26^{bc}
Calabar	79.67^{ab}	72.33^{f}	12.33^{de}	1.73^{a}
Okitipupa	60.00^{b}	48.00^{a}	35.00^{e}	1.52^{abc}
Ilesa	126.00^{a}	72.33^{bcde}	7.67^{bcd}	0.74^{de}
Akpoka	75.67^{ab}	51.67^{a}	20.67^{cde}	1.52^{abc}
Zaria	127.33^{a}	61.67^{bcd}	24.33^{a}	1.84^{cd}
Otun-Ekiti	121.00^{a}	55.00^{ab}	0.00^{de}	0.00^{f}
Kabba	90.00^{ab}	66.67^{abc}	30.33^{bc}	1.54^{abc}
Ilorin	66.00^{b}	41.33^{ab}	17.67^{abc}	0.72^{de}
Lafia	66.67^{b}	34.67^{def}	7.67^{e}	0.43^{ef}
Oro	53.69^{b}	32.00^{ef}	0.00^{ab}	0.00f
Kano	43.68^{c}	26.00^{f}	18.00^{cd}	0.34^{ab}

Means with the same letter(s) in each Column are not significantly different ($P<0.05$) according to Duncan's Multiple Range Test (DMRT). Note: ACC= Accessions, PH= Plant Height, NLP= Number of leaf per plant, NFP= Number of fruits per plant, FFWP= Fresh fruits yield per plant.

Table 4: Summary of Tomato accessions wilt severity recorded in across the three environments.

Accessions	Host Response	Accessions	Host Response
Ikole-Ekiti,	Moderately Resistant	Kabba	Moderately Susceptible
Calabar	Moderately Resistant	Ilorin	Highly Susceptible
Okitipupa	Moderately Susceptible	Lafia	Highly Susceptible
Ilesa	Highly Susceptible	Oro	Highly Susceptible
Akpoka	Moderately Susceptible	Kano	Resistant
Zaria	Moderately Resistant	Otun-Ekiti	Highly Susceptible

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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