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Survey of Plant Disease Prevalence on Okra (*Abelmoschus esculentus* (L.) Moench) at Rivers State University

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ABSTRACT

Survey of disease incidence and severity on okra (*Abelmoschus esculentus* (L.) Moench) was carried out to determine the geographic distribution and status of the diseases throughout Rivers State University. Three fields of okra were randomly selected and varied numbers of okra plant were observed and visually identified some disease symptoms associated with okra plant. Visual assessment method was used to estimate the qualitative and quantitative lesion that manifested on the plant stem and leaf. Percentage Ratio Scale for Visual Estimate of plant disease incidence and severity was adopted. Where the number of leaves/stems that were not diseased/infected was (0%), less than 10% infected (1), between 11-20% infected (3), between 21-39 infected (5), about 50-70% infected (7) and 71-100% infected (9). Inter-rating reliability/reproducibility of plant diseases between the observed fields was statistically determined using One-way t-Test analysis at 5% probability level. From the estimate, rust and ring spot occurred more frequently and had the highest percentage contribution of 14.0% each. Followed by leaf spot (13.1%), chlorosis and necrosis (9.2%), rot (8.3%), wilting (7.0%), mildew and scorch (6.7%) each, and curling (3.8%) which had the least percentage contribution of disease incidence in the fields. Result showed that disease severity/index of okra plants at the nearest minimum in the examined fields at Rivers States University was (25.2%).

KEY WORDS: Survey, Okra, Disease severity, Disease incidence, Reproducibility, Frequency

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INTRODUCTION

Okra (Moench.) is considered to be one of the world's oldest crops and is cultivated in almost all the Inter-tropical and Mediterranean regions for its young fruits. The vegetable is an important source of vitamins and essential mineral salts including calcium, which lacks in the diet of poor people of most of the developing countries of the world. But the yield obtained in several parts of the world is relatively lower, for which there are many constraints including prevalence of diseases caused by different pathogens (Ahmad *et al*.,2012; Arain *et al*., 2012).

Okra is one of the most important and valuable vegetables of the tropical and subtropical areas (Khan *et al*., 2005). In Nigeria okra is cultivated on several thousands of hectares but the yield obtained is not quite high, for which there are many constraints including prevalence of diseases caused by different biotic (pathogens) and abiotic (temperature, pH, soil moisture content, electrical conductivity, nutrients, etc) factors which are visibly seen and recognised as symptom of diseases (Shahid *et al*., 2007; Mukhtar *et al*., 2013).

Okra is susceptible to several diseases, both in the field and in storage (Aung and Prot, 1990; Floret and Serpantie, 1993; Rahoo *et al*., 2011; Qureshi *et al*., 2012; Vagelas and Gowen, 2012). Some varieties are highly susceptible to root decaying/root rot organisms while some are associated with both field and storage deterioration of the fruits which results in yield loss (Khan *et al*, 2005; Shahid *et al*., 2007). This may however affect the economy leading to scarcity of income and food.

Quantification of plant diseases especially the intensity of disease symptoms on individual units (Severity) is the basis for several research in plant pathology and related disciplines, which include evaluating treatment effect, monitoring `available resource and purpose – where accuracy is operationally defined as the closeness of the visual estimate to the actual value (Nutter *et al.*, 1991; Madden *et al.*, 2007).

Visual estimation is however referred to as the eye sensing stimulus (a diseased specimen), followed by perception of the sensation by our brains, which is in turn followed by a cognitive process based on our training, knowledge, and expertise to classify parts of the specimen as diseased (Madden *et al.*, 2007). Such fundamental process is sufficient to definitely ascertain incidence of disease, but more complex process is needed if an explicit estimate of severity based on the proportion of area diseased is to be made (Bock *et al.,* 2010).

Literatures have shown that about 70% of the populace of the world relies on agriculture and so, there is need for identification of the plant diseases in order to prevent losses within the yield (Khirade and Patil 2015). It is difficult and burdensome to observe plant diseases manually and would require enormous labour, expertise within the plant diseases, and excessive time interval (Madiwalar and Wyawahare 2017). Although sensor technology has been available to measure disease severity using the visible spectrum or other spectral range imaging, it is visual sensing and perception that still dominates, especially in field research (Moghadam *et al.,* 2017). One of the important and tedious tasks in agricultural practices is detection of disease on crops. It requires huge time as well as skilled labour (Shrestha *et al.,* 2020).

Diseases affect crop at all growth stages especially seedling stage, causing lesions and premature drying of young leaves which affect the panicle causing all kinds of physical manifestations (Getachew *et al.,* 2014). The fungi appear to overwinter as mycelia in the infected living leaves or dead plant debris in the soil and this can be influenced by high temperature, high relative humidity and leaf wetness are critical environmental factors that influence disease development ((Uddin, 2000; Ruiz, 2003). Disease incidence and severity in okra plant is of considerable economic importance and cause annual losses in tropics to an extent of 22 per cent (Hussain *et al*., 2011; Kayani *et al*., 2012).

Assessment and quantification of the incidence and severity of okra plant disease is important. This study is therefore aimed at surveying and assessing the incidence and severity of diseases in okra plant in order to determine the geographic distribution and status of the diseases throughout Rivers State University so as to prioritize research.

MATERIALS AND METHODS

Study Area and Sample Collection

A survey of okra fields located in different randomly selected localities of the major vegetable growing parts of Rivers State University was conducted for the determination of disease incidence and severity. The selected areas are the fields behind the department of Geology and opposite Faculty of Science, Rivers State University, Port Harcourt, Nigeria, which lies within latitudes 4^0 43’0743’07’’ and 4^0 54’3254’32’’N and longitudes 6^0 56’0456’04 and 7^0 03’2003’20’’E. The mean annual rainfall of the area is 2000mm and mean temperature of 29^0 C (Tubonimi and Udonna 2015). From each locality (Geology and opposite Faculty of Science), three fields of okra were randomly selected and varied numbers of okra plant were selected, observed and visually identified some disease symptoms associated with okra plant from each of the fields.

Determination of Plant Disease Symptoms in Okra plant at Rivers State University

Visual assessment method was used to describe and estimate the qualitative and quantitative damage/lesion that manifested on the plant stem and leaf.

Percentage Disease Incidence in Okra Plant at Rivers State University

The Ratio Scale for Visual Estimate of plant disease incidence and severity based on percentage or proportion was adopted. That is, plant disease incidence was determined by measuring the proportion of diseased plants per treatment or the proportion of diseased leaves per plant (treatment) as representations of incidence (Campbell and Madden, 1990; Madden and Hughes, 1995; Waller *et al*., 2002).

$$\text{Disease incidence (DI) expressed as} = \frac{\text{Number of infected plant parts}}{\text{Total number of plant assessed}} \times 100$$

Determination of Disease Severity in Okra Plant at Rivers State University

The Ordinal Scales (qualitative and quantitative) which descriptively defined the ranges of percentage scale was used to determine disease severity on the examined okra plants (Cainge *et al.,* 2020). The area or volume of plant tissue that was visibly diseased, usually relative to the total plant tissues were measured, recorded and was presented in percentage of the relevant host tissues or organ covered by symptom or lesion or damaged by the disease (Campbell and Madden, 1990; Binns, 1994; Cooke, 2006). The number and size of the lesions were measured which however expressed the extent of damage caused by the pathogen (Mousanejad *et al.*, 2010).

Rating was however done based on severity scale;

0: No disease on leaf/stem, 1: Small symptom covering <10% leaf/stem area, 3: Brown symptom 11-20% leaf/stem area, 5: spot/marginal symptom 21-39% leaf areas, 7: Circular brown sunken symptom 50-70% leaf/stem area and 9: Circular to irregular symptom 71-100% leaf/stem area.

Disease severity (DS)/Infection index =

$$\frac{\text{Sum of all disease rating}}{\text{Total no. of rating x maximum disease grade}} \text{ x } 100$$

Determination of Frequency of Occurrence and Percentage Distribution of Diseases in Okra Plant at Rivers State University

Disease symptoms such as chlorosis, necrosis, leaf spot, rust wilting damping off, etc on Okra leaves and stems in the respective fields were individually counted, and the percentage distribution of the diseases was calculated for okra fields at Rivers State University, Port Harcourt, Nigeria.

$$\% \text{ Contribution} = \frac{\text{Number of occurred symptom/disease incidence}}{\text{Total number of symptoms/disease incidence}} \text{ x } 100$$

Determination of Reliability/Reproducibility of Plant Disease Prevalence/Data Analysis at Rivers State University

Inter-rating reliability/reproducibility of plant diseases between the observed fields was carried out through statistical analysis using One-way t-Test analysis at 5% probability level which determined the extent to which okra plants were infected with the respective diseases at Rivers State University were infected.

RESULTS

The result of this research is presented in four different headings; investigation of the type of fungal disease incidence and percentage disease incidence in okra plant, determination of the frequency of occurrence and percentage contribution of each of the disease symptoms in okra plant, determination of the percentage disease severity/index on okra plant, and determination of reliability/reproducibility of plant disease prevalence on okra plant at Rivers State University, Port Harcourt, Nigeria.

Disease Incidence and Percentage disease Incidence in Okra Plant at Rivers State University

Table 4.1 shows some common fungal diseases/symptoms and percentage disease incidence in okra plant at the fields behind Department of Geology, Faculty of Science, Rivers State University. Ring spot had the highest percentage incidence (71.1) followed by leaf spot (63.2), necrosis (37.1), damping-off (37.0), rot (36.4), rust (34.4), chlorosis (29.2), scorch (27.0), wilting (25.3), mildew (17.6) and curling (11.8) being the least incidence.

Table 1. Diseases/Symptoms and Percentage Disease Incidence on Okra Plant at the Field behind Department of Geology, Rivers State University

S/N	Infections/Symptoms	Number of plants/parts Assessed	Number of infected plants/parts	Not infected plants/parts	% Disease Incidence
1	Chlorosis	1205	352	853	29.2
2	Necrosis	1184	439	745	37.1
3	Leaf spot	781	494	287	63.2
4	Rust	723	249	474	34.4
5	Wilting	826	209	617	25.3
6	Mildew	1210	213	997	17.6
7	Curling	671	79	592	11.8
8	Ring spot	1014	721	298	71.1
9	Damping-off	622	304	518	37.0
10	Scorch	972	214	578	27.0
11	Rot	857	312	545	36.4

Table 2 shows some common fungal diseases/symptoms and percentage disease incidence in okra plant at the fields Opposite Faculty of Science, Rivers State University. Leaf spot (41.8) had the highest percentage incidence, followed by rust (40.1), mildew (28.2), rot (25.3), scorch (25.1), wilting (23.0), damping-off (22.2), chlorosis (22.0), ring spot (19.4), necrosis (16.8) while curling (13.1) had the least incidence.

Table 2. Diseases/Symptoms and Percentage Disease Incidence on Okra Plant at the Fields opposite Faculty of Science, Rivers State University

S/N	Infections/Symptoms	Number of plants/parts Assessed	Number of infected plants/parts	Not infected plants/parts	% Disease Incidence
1	Chlorosis	1112	245	867	22.0
2	Necrosis	913	153	760	16.8
3	Leaf spot	843	352	491	41.8
4	Rust	1025	411	614	40.1
5	Wilting	892	205	687	23.0
6	Mildew	772	218	554	28.2
7	Curling	1271	167	1104	13.1
8	Ring spot	940	182	758	19.4
9	Damping-off	957	212	745	22.2
10	Scorch	872	219	653	25.1
11	Rot	875	221	654	25.3

Determination of Frequency of occurrence and Percentage contribution of each of the Disease Symptoms on Okra Plant at Rivers State University

Table 3 shows the frequency of disease occurrence and percentage contribution of disease symptoms in the fields (Department of Geology and Opposite Faculty of Science, Rivers State University). From the estimate, rust and ring spot occurred more frequently and had the highest percentage contribution of 14.0 each. Followed by leaf spot (13.1), chlorosis and necrosis (9.2), rot (8.3), wilting (7.0), mildew and scorch (6.7) each, and curling (3.8) which had the least percentage contribution of disease incidence in the fields.

Table 3. Frequency of Disease Occurrence and Percentage Contribution of Disease Symptoms on Okra Plant at Rivers State University

S/N	Infections/Symptoms	Total number of Plants/Parts Assessed	Total number of Disease/Symptom Occurrence	% Contribution of Symptom
1	Chlorosis	2317	597	9.2
2	Necrosis	2097	592	9.2
3	Leaf spot	1624	846	13.1
4	Rust	1566	905	14.0
5	Wilting	1851	454	7.0
6	Mildew	1982	431	6.7
7	Curling	1942	246	3.8
8	Ring spot	1954	903	14.0
9	Damping-off	1779	516	8.0
10	Scorch	1664	433	6.7
11	Rot	1732	533	8.3
Total		20508	6456	100

Determination of the Percentage Disease Severity/Index on Okra Plant at Rivers State University

Table 4 shows the disease severity scale/disease index, where the number of leaves/stems that were not diseased/infected was (14391), less than 10% infected area (1291), between 11-20% infected (2562) parts, between 21-39 infected (861) parts, about 50-70% infected (1702) parts and 71-100% infected (40) parts. And the disease severity/index of okra plants in the examined field at Rivers States University was (25.2%).

Table 4. Determination of Percentage Disease Severity/Index in Okra Plant at Rivers State University

Scale/Grade	Number of rating	Disease rating	%Disease Severity/Index
0	6456	0	
1	1291	1291	
3	1562	1562	
5	861	4305	
7	1702	11914	25.2
9	1040	9360	
Total	6456	28432	

Determination of Reliability/Reproducibility of Plant Disease Prevalence on Okra at Rivers State University

Table 4.5 shows the reproducibility of plant disease prevalence on okra at RSU. From the table, chlorosis, necrosis, leaf spot, rust, curling, damping-off and rot had significant effect on okra plant while wilting, mildew and scorch had highly significant impact on okra plants at RSU

Table 5. Reproducibility of Plant Disease Prevalence at Rivers State University

Symptoms	Rate of infection	t-value	Sig.
Chlorosis	298.50±75.66	5.579	0.11*
Necrosis	296.00±202.23	2.070	0.28*
Leaf spot	423.00±100.40	5.958	0.10*
Rust	330.00±114.55	4.074	0.15*
Wilting	207.00±2.82	103.500	0.01**
Mildew	215.50±3.53	86.200	0.01**
Curling	122.50±62.93	2.753	0.22*
Ring spot	451.50±381.13	1.675	0.34*
Damping-off	258.00±65.05	5.609	0.11*
Scorch	216.50±3.53	86.600	0.01**
Rot	266.50±64.34	5.857	0.12*

DISCUSSION

Results from the survey showed variations in the prevalence, incidence and severity of okra in different farms at Rivers state University. Similar results were also reported by Khan *et al*. (2005) and Shahid *et al*. (2007). The results of these workers confirmed the present findings regarding the prevalence of certain symptoms of plant diseases occurring on some species of vegetables. It is clear from the results of these researchers that okra crop was the most susceptible host of plant diseases in vegetable growing areas. These variations in infections and infestations are attributed to many environmental and edaphic factors, as differences in various climatic and edaphic factors of this zone (RSU) have been found to be suitable for disease prevalence. There are reports which confirmed that distribution, prevalence, incidence and severity of fungi diseases are affected by varying agro-climatic conditions of the areas, soil type, moisture, soil pH and particular cropping sequence (Hussain *et al*., 2011; Kayani *et al*., 2012).

Okra plants are also influenced by the biological, chemical and physical characteristics of the soil environment (Mukhtar *et al*., 2013; 2013a; 2013b). In Rivers State University, the prevalence of okra diseases is quiet low. This is because of higher amount of organic matter in the soil of the farms and also due to the fact that okra was sown in the soils which were fallow for the last few years (Sathish *et al.,* 2013). This fact is supported by the findings of other researchers who found that fallowing increased the organic matter contents of the soils and thereby reduced the number of nematodes and other soil pathogens (Aung and Prot, 1990; Floret and Serpantie, 1993; Rahoo *et al*., 2011; Qureshi *et al*., 2012; Vagelas and Gowen, 2012).

The frequency of occurrence and percentage contribution of rust and ring spot were found to be a bit higher from the research (Table 4.3). This high incidence is due to intense vegetable cropping pattern and the availability of suitable host throughout the year in these fields which allowed rapid multiplication of leaf spot and ring spot (Torkpo *et al.,* 2008; Nilesh 2012). Earlier a number of researchers reported that abundance of leaf spot and ring spot is highly dependent upon the presence of the suitable host plants (Cuc and Prot, 1992).

However, the relatively low incidence and severity of okra diseases at Rivers State University were also due to the cultivation of non-susceptible varieties, optimal temperature and comparatively adequate annual rainfall which has direct impact on the soil. These conditions would however not favour the multiplication, development and infection of okra plant. There are reports which showed that plant disease spread and multiplication are influenced by soil type (Trudgill *et al*., 2000; Das and Das, 2000; Bhosle *et al.,* 2004; Ravichandra and Krishnappa, 2004; Rathour *et al.,* 2006).

In this study, rust and ring spot had the highest frequency of disease incidence and percentage contribution of okra plant diseases. Next to these was leaf spot (Table 4.3) but disease severity was relatively low (Table 4.4) across the fields at RSU. This may be due to other factors of disease such as weather, host resistance, inoculum load and so on. The conditions that favour disease development differ slightly with the conditions that bring about the disease occurrence (Amadi *et al.,* 2009). A disease may occur but if the conditions are not right, its development could be halted due to some of those factors earlier mentioned. Fungi are spread primarily by spores which are produced in abundance (Amadi, 2005). The spores can be carried and disseminated by wind current, water (splashing or rain), soil (dust), insects, birds and the remains of plants that once were infected Oyetunji *et al*., 2012). The extent of dissemination of the disease inoculums will determine the development and severity of the disease.

CONCLUSION

It is concluded from the present studies that okra is attacked by several abiotic and biotic factors which is predominantly manifested in rust and ring spot especially at Rivers State University. However, the disease severity/index of okra plants in the examined fields at Rivers States University was (25.2%).

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