

Incidence and Severity of Diseases Associated with Rain-Fed Tomatoes in Benue State, Nigeria.

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Abstract: Farmers' fields were surveyed for incidence and severity of various diseases of tomato (*Lycopersicon esculentum*) in Benue State in the rainy seasons of 2012 and 2013. Data on farmers' characteristics in four major tomato growing Local Government Areas (LGAs) was collected through semi-structured interview of 40 heads of major tomato growing households, and analyzed by simple percentages. Disease incidence was assessed using the quadrat method. Results revealed that Majority of commercial tomato growers in the study area were female (65%), above 30 years of age (72.5%), attained mostly ordinary level of education (70%), married (90%), with a workforce of 6-10 (55%) and a tomato growing experience of 6-10 years (27%). All tomato farmers (100%) in the study were completely reliant on local tomato varieties. Tarka LGA recorded the highest and significantly different ($P < 0.05$) disease incidence (80.80%) followed by Buruku (76.04%), Gboko (71.50%) and lastly Ushongo (62.69%). Disease was highest in the month of July and symptoms progressed faster in the year 2012. Symptoms included leaf spots, blights, stem rots, fruit rot, plant wilt, seedling damping-off, leaf yellowing, growth of fungal material on plant body and stunted growth. Differences in total disease incidence between year 2012 (77.11%) and 2013 (68.41%) were statistically insignificant ($P < 0.05$). Correlation of farmers' attributes with disease incidence yielded positive coefficients (r) in correlation with Educational status (0.879), Non-rotational farming (0.838), Size of work force (0.152) and years of farming experience (0.080). Age of farmers (-0.695) and practice of rotational farming (-0.838) yielded negative correlation coefficients with incidence of tomato diseases in the study area. Tomato disease severity ratings in the study area are high and require urgent integrated disease management approaches to mitigate annual yield losses and compensate farmers' inputs.

Key words: Benue State, Farmers' Characteristics, Incidence, Severity, Tomato Diseases,

I. Introduction

Rainfall is a major determinant of agriculture in most parts of Africa. In Nigeria, about 90% of the country's food is produced by small-scale farmers cultivating tiny plots of land who depend on rainfall rather than irrigation systems [1]. In Benue State, vegetable cultivation is regarded mostly as a rainy season affair, although a few irrigated farms could also be found [2]. Fresh-marketed tomatoes are said to be the most valuable vegetable crop in the Nigerian savanna [3].

Apart from its nutritive value, recent reports of anticancer properties of tomato have only heightened the already rising economic profile of this very important vegetable [4, 5]. Unfortunately, tomato cultivation in Benue State has been consistently plagued by disease, with annual losses amounting to millions of Naira.

The present study was carried out to evaluate the incidence and severity of diseases of tomato (*Lycopersicon esculentum*) in major tomato growing Local Government Areas of the State with the following objectives:

- To collect data on characteristics of tomato farmers in Benue State
- To evaluate incidence and severity of tomato diseases on selected farm lands in Benue State in the rainy seasons of 2012 and 2013
- To investigate the relationship between selected characteristics of commercial tomato growers and disease incidence.

II. Materials and Methods

2.1. Description of study area

Benue state lies between latitude 6^o25'N and 8^o8'N and longitude 7^o47'E and 10^oE. It is located in the middle belt area of Nigeria and bordered by Nassarawa State to the North, Taraba to the East, Ebonyi and Cross River to the south and Kogi State to the West. Crops grown in Benue State include potatoes, cassava, soyabeans, guinea corn, flax, yams, beniseed, rice and vegetables, chiefly tomatoes.

2.2. Collection of data on characteristics of tomato farmers

Four major tomato growing Local Government Areas (LGAs) of Benue State were selected for the study, namely; Tarka, Gboko, Buruku and Ushongo. Semi-structured interviews were conducted on a total of 40 major commercial tomato growers, 10 in each LGA. Data collected included: Age of farmers, Sex, Marital Status, Years of tomato growing experience, Educational status and Farming practices.

2.3. Survey of incidence of major diseases of tomato in the study area

Survey of incidence and severity of tomato diseases was carried out in the months of June and July, 2012 and 2013, corresponding with the peak of rainy season and tomato harvest in the areas under survey. In each of the surveyed areas (i.e. Tarka, Gboko, Buruku and Ushongo Local Government Areas), 4 tomato farming locations each were randomly selected and assessed with the aid of 10m² quadrats mounted at 4 randomly selected points on each farm. An average number of 190 plants were counted per quadrat and a total of 48,685 tomato plants were assessed in the entire study duration. Data such as total number of plant stands per quadrat and number showing disease symptoms were collected. Disease incidence was determined as reported by Khanna *et al.* [6] thus:

$$DI = \left(\frac{n}{N}\right) \times 100 \quad (1)$$

Where, *DI* = Disease Incidence

n = Number of diseased plants sampled

N = Total number of plants sampled.

Disease severity was determined from disease incidence on a 0-4 scale as reported by Khanna *et al.* [6] as follows:

0 = 0 – Trace (No infection).

1 = 1 – 25% (Mild infection).

2 = 26- 50% (Moderate infection).

3 = 51-75% (High infection).

4 = 76-100% (Severe infection).

2.4. Data Analysis

Data on disease incidence was subjected to Analysis of Variance (ANOVA) at 5% level of probability. Pearson's correlation coefficients were used at 5% level of probability to test for the direction and strength of relationship between farmers' characteristics and disease incidence.

III. Results

Table 1. Characteristics of Tomato Growers in Major Tomato Growing Local Government Areas in Benue State

Characteristic	Percentage Occurrence				Average Total
	Ushongo	Tarka	Buruku	Gboko	
Gender					
Male	60.00	0.00	60.00	20.00	35.00
Female	40.00	100.00	40.00	80.00	65.00
Age (years) of producers					
Below 21	0.00	0.00	20.00	0.00	05.00
21 – 25	40.00	10.00	10.00	0.00	15.00
26 – 30	20.00	20.00	10.00	20.00	17.50
31 – 35	0.00	20.00	10.00	30.00	15.00
36 – 40	0.00	30.00	10.00	10.00	12.50
Above 40	40.00	20.00	40.00	40.00	45.00
Marital status					
Single	20.00	0.00	10.00	10.00	10.00
Married	80.00	100.00	90.00	90.00	90.00
Divorced	0.00	0.00	0.00	0.00	0.00
Years of tomato growing experience					
1 - 5	40.00	10.00	10.00	10.00	17.50
6 - 10	40.00	40.00	30.00	0.00	27.50
11 - 15	0.00	30.00	20.00	20.00	17.50
16 - 20	20.00	10.00	10.00	30.00	17.50
Above 20	0.00	10.00	30.00	40.00	20.00

Data on demographic characteristics of tomato growers in major growing LGAs of Benue State (TABLE 1), indicates that majority (65%) of tomato growers were female and mostly aged between 40 years and above (45%). 90% of tomato growers were married and majority of tomato farmers had between 6 – 10 years (27.5%) of tomato growing experience. Most tomato growing households had a work force of between 6 to 10 persons (55%), and practiced rotational farming (80%). 70% of tomato growers in the State had Ordinary level education, while 22.5% were illiterate, with only 7.5% haven acquired tertiary education. Gboko LGA had growers with the highest growing experience (Above 20years), while Ushongo LGA had the least (1-5 years). Ushongo and Gboko had the highest rotational to non-rotational cropping ratios of 100:0 respectively, compared to Buruku (80:20) and Tarka (40:60). Ushongo had growers with the highest tertiary educational level (20%), followed by Tarka (10%). Buruku and Gboko tomato growers had the largest tomato growing work force (above 20 persons). All tomato farmers (100%) in the studied areas used only local tomato varieties.

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Table 2a: Incidence and Severity of Tomato Diseases in Major Tomato Growing Areas of Benue State in June 2012

LGA	Disease Symptoms Observed										Disease Incidence (%)	Severity Rating
	BLT	SR	LS	WT	SG	LN	LY	FR	DOF	PFM		
Buruku	+	+	+	+	+	+	+	+	+	+	69.53	High
Gboko	+	+	+	+	+	+	+	+	+	-	66.01	High
Tarka	+	+	+	+	+	+	+	+	+	+	70.67	High
Ushongo	+	+	+	+	+	+	+	+	+	-	25.53	Mild
Average total											57.94	High

+ = Symptom present - = Symptom absent

BLT = Blight	LN = Leaf necrosis
SR = Stem rot	LY = Leaf yellowing
LS = Leaf spot	FR = Fruit rot
WT = Wilt	DOF = Damping off
SG = Stunted growth	PFM = Visible Presence of fungal material on plant body

The result of survey of incidence of tomato diseases in major tomato growing areas of Benue State, in the month of June, 2012, as presented in the TABLE 1, indicates a disease severity rating range of between mild to high. Tarka LGA had the highest disease incidence of 70.67% followed by Buruku LGA (69.53%). Ushongo had the least disease incidence (25.53%) in the month of June, 2012. Blights, stem rots, leaf spots, wilts, stunted growths, leaf necrosis, leaf yellowing, fruit rots and damping-offs, were found in all the LGAs. The presence of fungal material on plant body was observed only in Buruku and Ushongo LGAs.

Table 2b: Incidence and Severity of Tomato Diseases in Major Tomato Growing Areas of Benue State in July 2012.

LGA	Disease Symptoms Observed										Disease Incidence (%)	Severity Rating
	BLT	SR	LS	WT	SG	LN	LY	FR	DOF	PFM		
Buruku	+	+	+	+	+	+	+	+	+	+	95.54	Severe
Gboko	+	+	+	+	+	+	+	+	+	-	97.60	Severe
Tarka	+	+	+	+	+	+	+	+	+	+	100.00	Severe
Ushongo	+	+	+	+	+	+	+	+	+	-	92.00	Severe
Average Total											96.29	Severe

+ = Symptom present - = Symptom absent

BLT = Blight	LN = Leaf necrosis
SR = Stem rot	LY = Leaf yellowing
LS = Leaf spot	FR = Fruit rot
WT = Wilt	DOF = Damping off
SG = Stunted growth	PFM = Visible Presence of fungal material on plant

Survey of disease incidence of tomato in major tomato growing areas of Benue State in the month of July, 2012 (TABLE 2b), reveals severe disease incidence in all the surveyed areas. Tarka LGA had 100% disease incidence (the highest), followed by Gboko (97.60%). Ushongo LGA had the least disease incidence in the month of July, 2012. Symptoms such as blights, stem rots, leaf spots, wilts, stunted growths, leaf necrosis, leaf yellowing, fruit rots and damping-offs, were found in all the LGAs surveyed. The presence of fungal material on plant body was found only in Buruku and Ushongo LGAs.

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Table 3a: Incidence and Severity of Tomato Diseases in Major Tomato Growing Areas of Benue State in June 2013.

LGA	Disease Symptoms Observed										Disease Incidence (%)	Severity Rating
	BLT	SR	LS	WT	SG	LN	LY	FR	DOF	PFM		
Buruku	+	+	+	+	+	+	+	+	+	+	39.09	Moderate
Gboko	+	-	+	+	+	+	+	+	+	-	22.43	Mild
Tarka	-	-	+	+	+	+	+	+	-	-	52.54	High
Ushongo	+	+	+	+	+	+	+	+	+	-	33.24	Moderate
Average Total											36.83	Moderate

+ = Symptom present, - = Symptom absent

BLT = Blight
SR = Stem rot
LS = Leaf spot
WT = Wilt
SG = Stunted growth

LN = Leaf necrosis
LY = Leaf yellowing
FR = Fruit rot
DOF = Damping off
PFM = Visible Presence of fungal material on plant body

Tomato disease incidence in Benue in the month of June, 2013 (TABLE 3a.), ranged from mild in Gboko (22.43%), to moderate in Ushongo and Buruku LGAs (33.24% and 39.09% respectively), and high in Tarka. Leaf spots, wilts, stunted growth, leaf necrosis, leaf yellowing, and fruit rots, were common to all areas under survey. Blights and damping-offs were found in all except Tarka LGA. Stem rots were found in only Buruku and Ushongo LGAs. The presence of fungal growth on plant body was only observed in Buruku LGA.

Table 3b: Incidence and Severity of Tomato Diseases in Major Tomato Growing Areas of Benue State in July 2013

LGA	Disease Symptoms Observed										Disease Incidence (%)	Severity Rating
	BLT	SR	LS	WT	SG	LN	LY	FR	DOF	PFM		
Buruku	+	+	+	+	+	+	+	+	+	+	100.00	Severe
Gboko	+	+	+	+	+	+	+	+	+	+	100.00	Severe
Tarka	+	+	+	+	+	+	+	+	+	+	100.00	Severe
Ushongo	+	+	+	+	+	+	+	+	+	+	100.00	Severe
Average Total											100.00	Severe

+ = Symptom present- = Symptom absent

BLT = Blight
SR = Stem rot
LS = Leaf spot
WT = Wilt
SG = Stunted growth

LN = Leaf necrosis
LY = Leaf yellowing
FR = Fruit rot
DOF = Damping off
PFM = Visible Presence of fungal material on plant body

Incidence of tomato diseases in Benue in the month of July, 2013 (TABLE 3b.), revealed the presence of severe disease infections in surveyed areas. All examined symptoms such as blights, stem rots, leaf spots, wilts, stunted growths, leaf necrosis, leaf yellowing, fruit rots, damping-offs and presence of fungal material on plant body, were found in all the surveyed LGAs. Disease incidence reached 100% in all the surveyed LGAs.

Table 4. Effect of Month of Occurrence on Disease Incidence

Month	Overall Disease Incidence (%)
June	47.38 ^a
July	98.14 ^b

Values bearing different superscripts are significantly different (P <0.05)

Results of comparative monthly disease incidence (TABLE 4), indicates higher overall disease incidence in the month of July (98.14%), compared to the month of June (47.38%). The difference in disease incidence between the months is statistically significant (P <0.05).

Table 5. Effect of year of Occurrence on Disease Incidence

Year	Overall Disease Incidence (%)
2012	77.11 ^a
2013	68.41 ^a

Values bearing same superscripts are not significantly different (P <0.05)

Disease incidence of tomato in Benue State, compared on yearly basis (TABLE 5), indicates a higher overall disease occurrence (77.11%) in the year 2012, compared to 68.41% in the year 2013. The difference in disease incidence between the years is statistically not significant (P <0.05).

Table 6. Effect of Survey Location on Disease Incidence

LGA	Overall Disease Incidence (%)
Buruku	76.04 ^{ab}
Gboko	71.50 ^{ab}
Tarka	80.80 ^b
Ushongo	62.69 ^a

Values bearing same superscripts are not significantly different (P <0.05)

Values bearing different superscripts are significantly different (P <0.05)

Overall disease incidence of tomato in Benue State from 2012 to 2013, compared by location (TABLE 6), indicates highest disease incidence in Tarka LGA (80.80%), followed by Buruku (76.04%), Gboko (71.50%) and lastly Ushongo (62.69%). Tarka and Gboko differ significantly in disease incidence, but do not differ significantly from Buruku and Gboko (P=0.05).

Table 7. Correlation Analysis of Some Selected Farmers' Attributes and Incidence of Tomato Diseases

Farmers' Attributes	r
Age	-.695
Educational status	.879
Farming Practice	
Non-rotational Farming	.838
Rotational Farming	-.838
Size of work force	.152
Years of farming experience	.080

r = Pearson's correlation coefficient

Results of Pearson correlation analysis of the possible relationships between selected farmers' attributes and disease incidence in the study areas (TABLE 7) indicates positive correlations of disease incidence with Size of work force, Educational status, and the practice of non-rotational farming. Correlations of disease incidence with Age of farmers and practice of rotational farming were negative. The strength of correlation of disease incidence with size of work force was weak (.152). A weakly positive correlation (.08) was also observed in the relationship between years of farming experience and incidence of tomato diseases.

IV. Discussion

Tomato plants in the studied areas showed various disease symptoms such as blights, leaf spots, fruit rots, wilts, damping offs, stem rots, and the presence of fungal growths on plant surfaces. Symptoms observed were similar to those reported by Bem[7] in a preliminary study of incidence of tomato diseases in selected areas of Benue State. Villarreal [8] also mentioned that the major fungal diseases of tomato include leaf mould, *Fusarium* wilt, target spot or early blight and leaf spots.

Occurrence of diseases of tomato in major growing areas of Benue State attained hundred percent (100%) in the months of July 2012 and 2013. This corresponds with the peak of the rainy seasons and the prevalence of high relative humidity, an ideal condition for the development and spread of fungal, bacterial and several other plant pathogens [9, 10].

Majority of respondents in the reported study (70%) had attained only ordinary level (O'level) of formal education. In a similar study by Massomo *et al.* [11], it was also reported that majority of vegetable growers in Tanzania did not attend formal school beyond the secondary level. Incidence of plant diseases have been severally attributed to decline in educational status of plant growers and improvements in disease management capacity has been reported for farmers who graduated from various Farmer Field Schools [12, 13].

Tarka LGA recorded the highest tomato disease incidence, followed by Buruku, Gboko and Ushongo LGAs. Disease incidence correlated negatively with age of farmers and the use of soil rotation. A negative correlation with age of farmers implies a decline in disease with increase in farmers' age. Dominance of older tomato farmers (Above 40years of age) in Benue State had been also previously reported by Abur [14], in a study to assess the effect of irrigated tomato farming on resource productivity of farmers in Vandeikya Local Government Area of Benue State, Nigeria. In a study to comparatively analyze tomato under irrigation and rain-fed systems in selected Local Government Areas of Kogi and Benue States, Nigeria, Ayoola [15] also mentioned that majority of tomato farmers were above 50 years of age with low literacy. Older farmers (40 years and above) represent maturity, higher stability and greater availability of farmers as opposed to younger more mobile farmers who often absent themselves from farming activities either for the purpose of schooling or in search of white collar jobs. Greater on-farm presence of farmers could enhance prompter responses to disease outbreaks and consequently confer some added advantage in disease management and crop protection.

Increase in years of tomato farming experience as well as increased attainment of Ordinary level of formal education (O'Level) and use of larger work force did not translate to a reciprocal decline in incidence of tomato diseases ($r = -ve$). This implies that the occurrence of tomato diseases in the studied areas was not a result of total absence of formal education and unavailability of experienced manpower, but a result of the absence of sufficient and relevant education on effective disease management approaches in tomato production. High incidence of tomato diseases in the surveyed areas could also be as a result of the total dependence of farmers on local varieties.

Majority of tomato farmers in the study area were female (65%). Abur [14] also reported a higher female to male ratio in the practice of irrigated tomato farming in Vandeikya LGA of Benue State. Higher numbers of female tomato farmers in the study area can be accounted for by the common notion in the study area that vegetable farming was a thing for women and not for men who should be pre-occupied with more 'masculine' agriculture, such as the cultivation of tubers, cereals, fruits etc.

Local Government Areas with higher practice of soil rotation recorded lower incidences of tomato diseases. Soil rotation reduces population of pathogen inoculum and has been reported to significantly reduce disease of crop plants in infected fields. Hill and Waller [16] also maintained that drastic tomato crop failures were seemingly due to a joint disease/nematode complex, which normally builds up partly as a result of lack of crop rotation.

V. Conclusion

Disease indices in the studied areas were significantly high ($P < 0.05$). An integrated approach involving massive farmer education on the importance of crop rotation, right usage of pesticides, fertilizers and use of resistant varieties, is imperative for sustainable tomato production, enhanced yield and improved productivity by tomato producers in the study area. Mitigated annual yield losses will further boost financial returns and encourage farmer participation in extensive production of the crop in the State.

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