

# Assessment Of Farmers' Perception Of Bacterial Wilt Disease In Selected Districts In Bong And Nimba Counties Liberia

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**Abstract:** *Ralstoniasolanacearum* is a casual organism that causes bacterial wilt disease (BWT) of solanaceae crop and a major threat to tomato production causing up to 100% yield loss. The pathogen is widely distributed soil borne plant pathogenic bacteria which impact negatively in tomato production in Liberia. Surveys on BWT disease were conducted to provide information on incidence and severity, as well as farmers' perception of the disease using questionnaires. The surveys started from September to October, 2017 in 80 tomato farms within four districts: Gbarlay-Geh, Mentiamahn, Suakoko, and Kpiai, in Nimba and Bong counties of Liberia. In each district, five communities were selected while purposive and stratified sampling methods used. Affected tomato crop showing the symptom of BWT disease were extracted from the field cut at the base suspended in clean glass of distilled water for identification of the pathogen. The surveys revealed that most (74.31%) of the farmers had knowledge on the disease. From the survey most of the tomato farmers were women (54%) and more than 60% of the farmers had basic education. Over 62% of the farmers engaged in tomato production are between the ages of 29-48 years and 87% of the farmers have less than 10 years experience. The survey also revealed that over 50% of the farmers obtained their seeds from other farmers and about 60% of them preferred local varieties because of their resistance to BWT. 67% of the farmers recognize BWT as the major constraint in tomato production and the disease is mostly observed by farmers (74%) when the crop is matured and during the wet season (82%). From the survey disease incidence and severity varied significantly between districts. The highest incidence and severity of BWT disease were observed at Kpein and Negbein (100%) in Mentiamahn district and the least in Gayetaryeah in Bong County in Kpiai District which showed 13.5% incidence and 9.5% severity. In general 60% of the communities showed incidence of BWT of 30% and above and 45% showed severity of 30% and above.

**Key words:** BWT disease, incidence, severity, tomato

## 1. Introduction

Tomato (*Lycopersicon esculentum* Mill.) is one of the most essential vegetables used globally. As it is a relatively short duration crop and gives a high yield, it is economically good and the area under farming is increasing daily [1]. Tomato belongs to the Solanaceae family. This family also includes other well-known species, such as potato, tobacco, peppers and eggplant. The crop is one of the most important "protective foods" because of its special nutritive value. It is also considered as the most useful vegetable with wide usage globally. It is used for preparing several dishes such as: soup, salad, pickles, ketchup, puree, sauces and in many other ways. Also be used in vegetable salad for good health. The crop has very few competitors in the value addition chain of processing. Tomato is rich in minerals, vitamins, essential amino acids, sugars and dietary fibers. It contains vitamin B, C, iron and phosphorus. About 41% Liberians have unacceptable food consumption [2], i.e. they consume

limited or insufficient nutritious foods to maintain an active and healthy life. Of these, 13% have an extremely one-sided consumption pattern, mainly surviving solely on rice, roots and tubers. They are classified as having poor food consumption. Therefore, improving vegetables cultivation precisely tomato production will help decrease some nutritional problems in Liberia. Plant diseases are regarded as major constraint to global food production reducing yield and increasing malnutrition problems thus creating food shortage for the growing human population. According to [3], bacterial wilt caused by *Ralstoniasolanacearum* is considered one of the greatest plant diseases and commonly distributed soil borne plant pathogenic bacteria in the world. There are five different races of the pathogen *R. solanacearum* causing wilting in different crops species. However, race one is responsible for wilting in solanaceae crops. The disease (BWT) affects over 200 plant species in 50 families [4] and remains the main biotic factor preventing growth and development of

several essential crops family Solanaceae, including potato, tomato, eggplant, pepper and tobacco [5], e.g. ground nut and French bean, and several tree and shrub hosts [3]. Tomato BWT is observed as the most important soil-borne bacterial disease and other solanaceous crops, its effect is more pronounced during the dry season [6]. The disease occurs widely in most regions of the world; tropical, subtropical and temperate causing significant yield losses up to 2-100% [7]. Tomato production in Liberia is limited by several factors, which BWT is considered as the major constraint affecting the crop. *Ralstonia solanacearum* causal agent of the disease causes substantial economic loss to tomato production worldwide which Liberia is not an exception. At Central Agricultural Research Institute (CARI) in Suakoko Bong County Liberia, AVRDC tomato demonstration plots were destroyed by BWT in June 2017 which resulted to complete crop failure (personal observation). There is inadequate information regarding tomato production and the comparative effect of different tomato varieties are lacking as to the type of variety to be used as well as the

best chemical pesticides for the management of the disease (BWT). The aim of this study was to assess the incidence, severity and farmers perception of the disease in selected communities in Bong and Nimba counties.

## 2. Material and Methods

A field survey to assess the incidence, severity and farmers' perception of the bacterial wilt disease of tomato was conducted. The study was conducted in September 2017 in Nimba and Bong Counties. The climate of Bong County is tropical, hot and humid temperature ranges from 65°F to 80°F. It has two seasons, rainy and dry seasons. The rainy season lasted from mid-April to Mid-October. The dry season starts in November and ends in April. The county has conventional types of rainfall of 70-80 inches. Nimba County has an average temperature of 25.4 °C with 3981 mm annual precipitation falls annually. Four districts were selected for the survey, two from each county. Twenty communities within the four districts were selected

**Table 1:** List of Counties, Districts and communities surveyed

| County | District    | Latitude    | Longitude   | Communities  |
|--------|-------------|-------------|-------------|--|
| Nimba  | Gbarlay-Geh | 7° 09' 60"N | 8° 24' 59"W | Mabour village, Kiarlay, Zorgowee, Zualay and Nyantouh |
| Nimba  | Mentiamahn  | 6° 44' 17"N | 8° 52' 29"W | Negbeyee, Wentiapa, Kpeiyee, Dupuyee and Sokopa        |
| Bong   | Suakoko     | 6° 59' 20"N | 9° 34' 53"W | Rehab, Gbondai, Glaykaciasue, Gbomue and Gbayeah       |
| Bong   | Kpaii       | 6° 58' 35"N | 9° 13' 51"W | Baila, Tomato Camp, Dutar, Gaytayeah and Gaillah       |

Surveys were conducted in selected communities in major tomato growing districts in Bong and Nimba Counties of Liberia between September and mid-October, 2017. Incidence and severity of Bacterial wilt disease of tomato were documented. The survey on selected tomato farms were carried out at both the vegetative and fruiting stages for all districts in the counties. The distance between selected farms in each community was about 0.5 to 1.5 km apart. In a district, a total of 20 tomato farms were randomly selected and screened. Farmers were interviewed with the help of a questionnaire to gather the following information: their knowledge of the BWT disease, seeds source, preferred varieties, types of fertilizer used, major diseases they encountered, and management practices employed by the farmers. Surveyed fields were then considered for incidence and severity of bacterial wilt disease. In selected fields, three 3 m x 4 m plots were demarcated in every corners and one in the middle for assessment. Percentage disease incidence per plot was calculated based on the work of [8], as percentage plants showing symptom of disease using the formula

$$I = \frac{NPSWS \times 100}{NPPP}$$

Where I= Incidence of bacterial wilt in percentage;  
NPSWS= Number of plant showing wilt symptoms in a plot and NPPP= Number of plants per plot

Disease severity scoring was done using visual assessment, on six point scale (0= No wilt symptom = Immune, 1= One leaf wilted = highly resistant, 2= 2 or more leaves wilted = moderately resistant, 3 = all leaves

except the tip wilted = Moderately Susceptible, 4= Whole plant wilted = Susceptible, 5= Death (collapse) of the whole plant = highly susceptible). The six-point scale used was proposed by [8]. Disease severity, percent severity index (PSI) described by [9], were calculated using the Formula -  $\Sigma [(scores \times 100) / (number \text{ of plants rated} \times \text{maximum scale of the scores})]$  for each scoring date. Affected tomato plants were cut at the base near the root zone, washed in tap water and rinse in distilled water. The plants were also suspended in distilled water for identification of the pathogen, *Ralstonia solanacearum*. The wilted plants were split opened to further confirm the presence of BWT disease (brown discoloration of plant tissues). Plate 1: show the ooze of the bacterial (*R. solanacearum*).



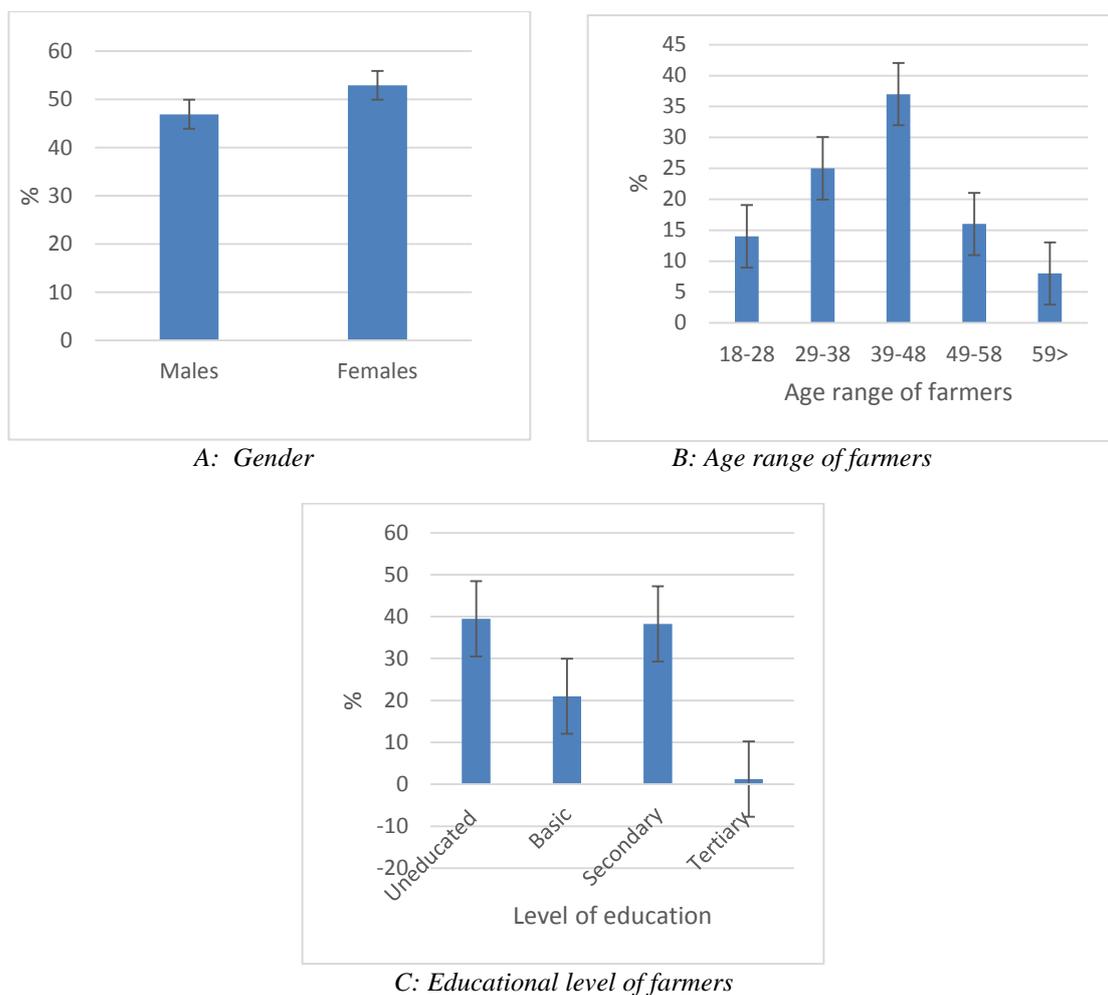
**Plate 1:** Bacterial ooze from the root of affected plant

Data collected included: incidence and severity of BWT, insect pest damage, nutrients deficiency, as well as other diseases identified. Disease severity and nutrients deficiency were scored using visual assessment, whereas disease incidence and severity were calculated as mentioned above in surveyed fields. Total yield per variety was determined by the weight of fruit harvested from 5 plants excluding the border rows. Diseased fruits and insect damaged were weighed separately. For data analysis, all count data were subjected to analysis of variance (ANOVA), using Genstat Statistical package [10], and SPSS for uncounted data. Treatment means was separated by LSD at 5 % probability.

## Results and Discussion

### Gender, Age and Educational levels of respondents:

Results from the survey conducted showed that more females (54%) cultivate tomato than males (Fig. 1A). This study supports the findings [11], who observed that more females engage in subsistence cropping in most rural areas of South Africa, women are the major subsistence farmers, providing the basis of house-hold and community sustainable livelihood. The results also suggest that women engage in fast income generating activities. Figure 1B shows the age range of farmers engaged in tomato production. Most of the farmers engaged in tomato production are within the age 39 – 48 (37%) year range and the least are farmers above 59 years old (8%). The pyramid shaped of the graph depicts that as farmers become more energetic they engage more in tomato production and less so when they become older (Fig. 1B).



**Figure 1:** Gender (A), age (B) and educational levels (C) of respondents

Figure 1C shows the educational levels of the respondents. Over 60% of the respondents have at least basic education with about 38% of the farmers not educated. Farmers' education level is a key component necessary for improved productivity since educated farmers may understand and easily accept new technologies.

**Sources of seeds, Farmers experience and Major constraints:** Farmers obtained most (51%) of their seeds used in tomato production from other farmers (Figure 2). Other sources of seeds include market (28%) and agricultural based organizations (21%). Farmers borrowing

of seeds from each other are a major contributing factor of spreading plant diseases. This observation supports the findings of [12], [13], that farmers stored seeds, nursery stock or propagative material that carry various pathogens and share among themselves promoting disease development resulting in crop failure. Also these pathogens increase the amount of initial inoculum within the crop and favor the development of epidemics greatly. Majority of the farmers (87%) indicated that they have been in the tomato production for less than 10 years followed by farmers who have between 11– 20 years experience (Figure 2). Less than 4.0% of farmers had

more than 20years experience in tomato production. This is an indication that most of the farmers are young and it

will be important to offer them the needed training so as to boast tomato production in Liberia.

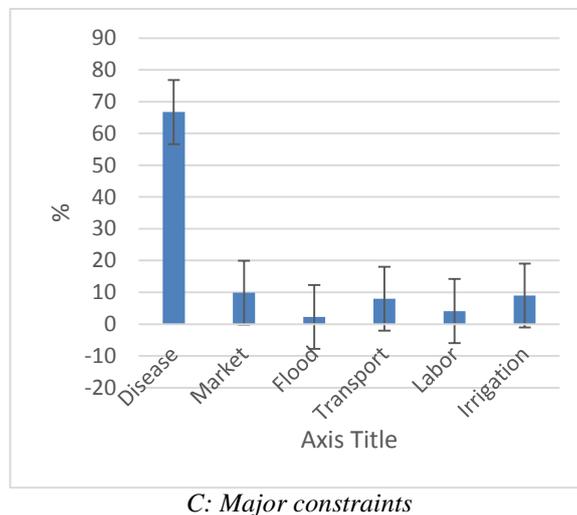
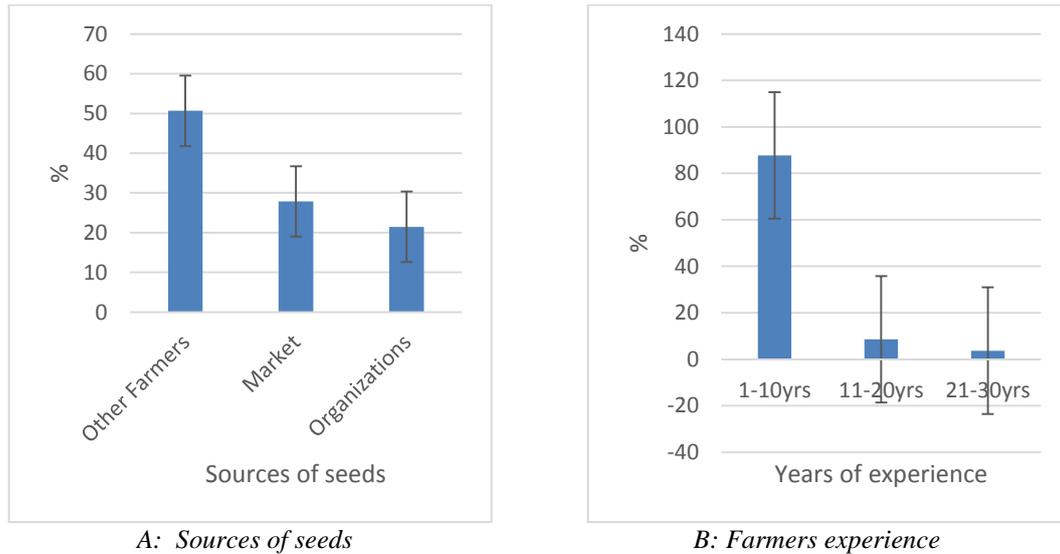


Figure 2: Sources of seeds, Farmers’ experience and Major constraints affecting farmers:

Farmers recognized the effect of diseases (67%) on their tomato production as the major constraints (Figure 2C). Irrigation, market, transport, flood and labor were also recognized as constraints but of minor importance. This result proved that disease is a serious challenge to tomato

cultivation in Liberia and hence should be given special attention. In addition, the interviewed farmers have some knowledge on disease management and they must be trained on its management to increase their tomato productivity.

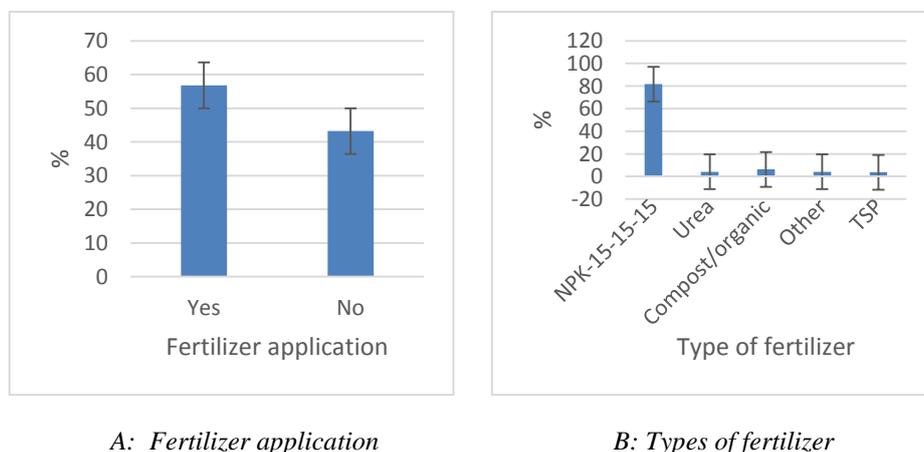


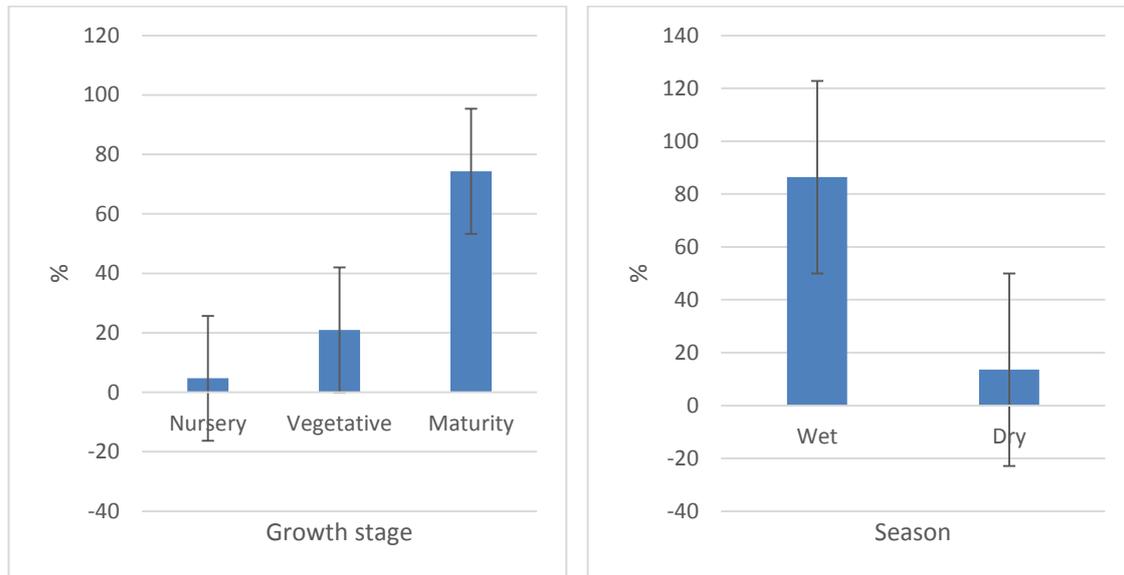
Figure 3: Use of Fertilizer (A) and Types of Fertilizer (B)

**Fertilizer use and Types:**It was observed from the studied that majority (57%) of the tomato farmers used fertilizers while 43.0% of the farmers do not use fertilizer (Figure 3A).The farmers recognized the importance of fertilizer in increasing their yield but added that it is expensive and increases their cost of production. Most of the farmers (82%) who use fertilizer use NPK: 15-15-15. Few of the farmers also apply urea, TSP, compost and other organic fertilizers (Figure 3B) this indicates that these farmers know the impacts of fertilizer on crop performance in term of productivity. The farmers also

argued that the crop yielded its genetic potential when required nutrients are applied at the right time.

**Growth stage and Season farmers observe BWT disease:**

The findings of the research revealed that these tomato farmers have some knowledge on the bacteria wilt disease. Most (74.3%) of the farmers experienced the disease during the maturity stage of the tomato crop while 21.0% observed it at vegetative stage (Figure 4A). very few (4.70%) of the farmers observed BWT disease at the nursery stage.



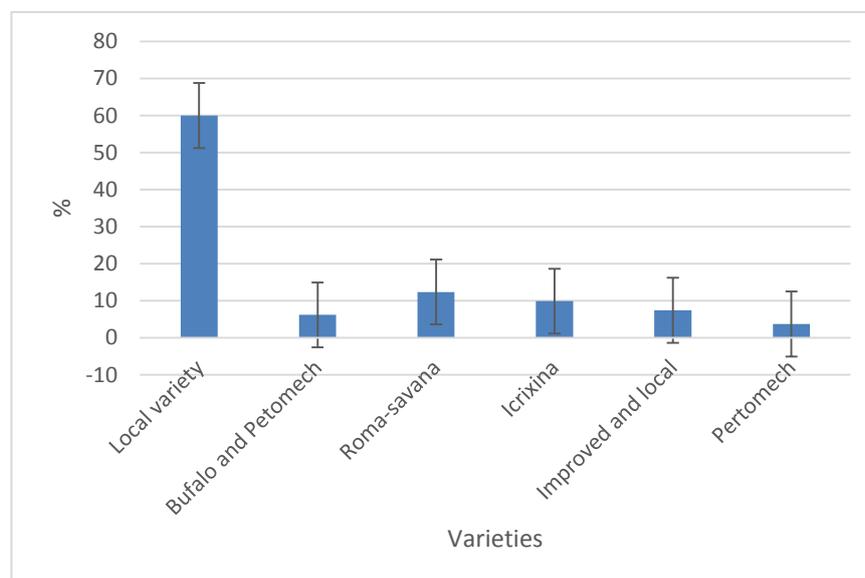
A: Growth stage

B: Season

**Figure 4:** Growth stage (A) and season (B) farmer observed the presence of BWT disease.

Majority (86.4%) of the tomato farmers observed bacterial wilt disease in their field during the wet season while few (13.6%) observed the disease in the dry season (Figure 4B). Apart from BWT disease, other disease symptoms were also observed by farmers such as Wilting of plant, leaves becoming yellowish, nematode gall on root,

wilting, fruit rot and leaf dropping. Since the disease is most common in the wet season as reported by the farmers, it proves that BWT disease is not a strange disease encountered by them. In addition, BWT disease is a major challenge to most vegetable precisely the solanaceae crops.



**Figure 5:** Farmers preferred varieties

**Farmers preferred varieties:** Most (60.0%) of the tomato farmers interviewed preferred local variety (Nimba-1 and Gaytaryeah) because of its resistant level to bacterial wilt disease and high yield. The acceptance of some improved varieties (Bufalo and Petomech, Roma-savana, Icrixina, improved and local and petomech) was generally low (Figure 5) and significantly lower than the local variety. The results from the study reveal that farmers

preferred local tomato over improved varieties. In addition, the local varieties are easily affordable by farmers in terms of planting and consumption purposes. However, they would love planting improved varieties for better market but the problem of bacterial wilt disease is a major constraint. The farmers stated that they could engage in robust tomato production using improved resistant tomato varieties if available.

**Table 2:** Mean incidence and severity of Bacterial Wilt Disease in the Surveyed Areas

| Community      | Mean incidence | Mean severity |
|----------------|----------------|---------------|
| Kpein          | 100.00 a       | 100.00 a      |
| Negbeein       | 100.00 a       | 100.00 a      |
| Sokopa         | 56.25 b        | 48.75 b       |
| Zualay         | 55.00 b        | 43.75 b       |
| Glakaciasue    | 49.50 bc       | 43.73 b       |
| Dukpuyee       | 47.00 bc       | 43.75 b       |
| Menyenpa       | 43.75 bcd      | 35.50 bc      |
| Dutar          | 42.50 bcde     | 35.00 bc      |
| Gbondoi        | 38.00 bcdef    | 33.00 bcd     |
| Gboimo         | 35.50 bcdef    | 26.75 bcd     |
| Kailay         | 34.00 bcdef    | 25.50 bcd     |
| zorgowee       | 31.25 bcdef    | 24.50 bcd     |
| Nyantou        | 24.25 cdef     | 16.00 cd      |
| Baila          | 19.50 def      | 15.00 cd      |
| Galai          | 19.50 def      | 14.75 cd      |
| Gbayeah        | 18.75 def      | 14.50 cd      |
| Tomato camp    | 18.25 def      | 13.25 cd      |
| Rehab          | 17.50 ef       | 13.25 cd      |
| Mabour-Village | 16.00 f        | 9.75 d        |
| Gayetaryeah    | 13.50 f        | 9.50 d        |

Within a column numbers followed by similar letter(s) are not significant at LSD 5%

**Incidence and severity of BWT:** Results from the survey showed that incidence and severity of BWT varied significantly between districts (Table 2). Two districts in Nimba County, Kpein and Negbeein communities in Mentiamahn District recorded the highest (100%) incidence and severity of BWT disease while Gayetaryeah in Bong County in Kpiai District recorded the least (13.5%) incidence and (9.5%) severity. Also Zualay community in Gbarlay-Geh District Nimba recorded the highest (55.0%) incidence and (43.8%) severity in the district with Mabour Village the least (16.0%) incidence and (9.8%) severity. Glakaciasue in Suakoko District Bong counties recorded the highest (49.5%) incidence and (43.7%) severity whereas Rehab community recorded the least (17.5%) incidence and (13.3%) severity respectively in the district. Kpein and Negbeein communities are within the same district in Nimba County, there was a higher possibility of exchange of infected or susceptible tomato varieties for planting among farmers. This may have resulted in the same incidences of disease recorded in the communities as reported [14], that exchange of planting materials are a possible cause of high incidence and severity.

## Conclusion

The study conducted in the two counties (Bong and Nimba) revealed that bacterial wilt disease caused by the pathogen *Ralstoniasolanacearum* is a major constraint to tomato production in Liberia. The disease caused up to 100% yield losses and has resulted in high shortage of the crop produce on market. Majority of the tomato farmers interviewed were women with in the age range of 37- 48

years. The highest (100%) incidence and severity of BTW were recorded in Kpein and Negbeein in Nimba County.

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