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*Full length Research paper*

# Screening of Tomato Varieties' Response to Bacterial Wilt Disease at CARI, Liberia

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**Tomato (*Lycopersiconesculemtun)* is an important vegetable crop produced and consumed worldwide. Tomato production in Liberia is on the decline due to serious disease problems. Introduction of improved varieties is usually difficult due to the effect of these diseases. The crop is mostly affected by one of the most devastating plant pathogenic gram negative bacterium *Ralstoniasolanacerum* causing major yield losses up to 100% in susceptible varieties worldwide. In the dry season of 2017 a trial was established to screen 10 tomato varieties and evaluate the effect of four organic pesticides against BWT disease. The trial was repeated in the wet season of 2018. The experimental design was a randomized complete block in a factorial arrangement with four replications. Four of the varieties; Mozat, Icrixina, Gaytayeah-2 and Petomech all perished before the end of the trial. Two of the 10 varieties, Nimba-1 and Gaytayeah-1 were resistant (0.0% incidence rates) to BWT disease. Boufolo variety showed good resistance (23.7% incident rate) which was significantly better than the other varieties which had over 50% incident rate. All the pesticides gave similar efficacy levels as the Control hence in effective in controlling the disease. Gaytayeah-1 and Nimba-1 gave the highest fruit yields which were significantly higher than the other varieties. A strong correlation between disease incidence and total fruit yield was observed. Introduction of new varieties for screening and the evaluation of more pesticides is recommended.**

**Key worlds:** Tomato varieties, pesticides, screening, BW disease

## INTRODUCTION

The tomato (*Lycopersiconesculemtun)* belongs to the family *Lycopersicae*. It has become one of the world's main vegetable and is identified as protecting food due to its distinct nutritious value; also for its wide spread cultivation globally. The high consumption rate for tomato worldwide has increased tremendously in recent years due to its different usefulness in raw, cooked, and processed food as well as its nutritional contents (Chaudhary*et al.,*2019).The crop is considered one of the most important vegetable crops produced for its fleshy fruits. According to Nasir*et al*. (2015) tomato contains important polysaccharides like cellulose, arabinoxylan, xylan, pectin and arabinogalactons and they about 0.7% of tomato juice. Also it is notable that tomatoes are not only sold fresh, but also processed as soups, sauces, juices or powder concentrates. Tomatoes are considered major source of dietary of the antioxidant lycopene, which has been linked to many health benefits, including reduced risk of heart disease and cancer. Hence, its production and consumption are constantly increasing globally. Data on tomato production presented by Sagarpa (2015), Mexico is the leading exporter of tomatoes in the world with 2.8 million tons in 2014. The pathogens causing plant diseases are very difficult to control because their populations are adaptable in time, space and genotype. According to FAO (2017) report, plant diseases and pest impose serious threat to global food security because they can damage crops, thus reducing the availability and access to food, increasing in the cost of food. Hence, their present in agro-ecological zones pose starvation, high prices for food commodities, loss of income and death. Trans-boundary plant pest and diseases affect food crops leading to significant losses to farmers produces (FAO,2019). It may also negatively

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affect the palatability of food resulting in changes to the traditional food preference of population. The outbreaks of plant disease in farmers' fields are known to cause great disaster affecting the wellbeing of mankind. Bacterial wilt caused by a gram negative bacterium (*Ralstoniasolanacerum*) is one of the most devastating bacterial diseases affecting tomato and many solanaceous crop worldwide and it is difficult to control as the pathogen lives within a large temperate range(10 to 41$^{o}$C); also in various environments ( Yang *etal.*2016). Also the bacterium infects over 50 plant families and cause bacterial wilting of more than 250 plant species (Salgon *et al*., 2018).The pathogen *R.solanacearum* normally enters the root through wounds and natural opening caused by the emergence of lateral roots or roots through wounds developed as roots growth through the soil (Caldwell *et al*., 2017).Its presence in the root system the bacterium enters the vasculature, which permits them to migrate through the root to the shoot. The control of the disease is extremely difficult because of its wide range, long survival in the soil, many modes of spread, survival potential as the latent infection, ability to grow endophytically, relationship with weeds and its genetically diverse (Sarkar and Chaudhuri, 2016). The uses of resistant varieties are the most successful method in plant disease management (Yuliar and Toyota,2015). The disease is known to cause significant yield losses from 10 to 100% particularly in susceptible varieties. Effective management practice to control BWT is a serious concern to researchers and farmers. Therefore, the present study seeks to identify resistant tomato variety/varieties as well as effective pesticides that will control the disease and improve farmers' wellbeing.

## MATERIAL METHODS

Field experiments were conducted in CARI which is in the forest ecological zone and lies within latitude N 06.99929$^{o}$ and Longitudes W 009.56120$^{o}$ at an elevation of 260 m. The experiment were conducted in the dry from October to December 2017 and repeated in the wet June to September 2018.Hotspot of BWT was used to test ten tomato varieties response to the pathogen (*R.solanacerum* ). Four inorganic pesticides were also evaluated for their efficacy in controlling the disease. Subplot (2m$^{2}$) was used for each tomato variety with the planting distance of 0.5 m between plants and 0.6 m in rows. Field was layout in randomized complete block designed (RCBD) in factorial arrangement with four replications.

Sticks and reeves were used to prepare elevated nursery bed at the height of 1m and the length 7m while transparent plastic sheet used for covering. Decomposed (100 kg) cow manure was evenly mixed with top soil and the soil sterilized with 30 grams of Copper oxycholorides dissolved in 10 liters of water for the nursery. After five days, 10 tomato varieties (six improved and four local) were surface sterilized in 70 % sodium hypochloride (bleach) to reduce seed-borne pathogen. Seeds were stored in sterilized tissue paper three days for pre germination before sowing. Best agronomy practices for tomato production were ensured to maintain healthy seedlings. Tomato varieties and their origins are presented in Table 1.

A week before transplanting, organic manure (cow) 5 tons /ha was in cooperated in each plot and watered while 23day old seedlings transplanted. Additionally, inorganic fertilizers -NPK-15-15-15 and urea were applied at various rates with different time interval respectively. One week after transplanting, 150 kg/ha NPK-15-15-15 was applied followed by watering while 100 kg/ha urea applied two weeks after transplanting and watered the following day. Subsequently, watering was done when necessary. Routine manual weeding and other field maintenance were carried out. Two to three weeks after crop establishment, four of the ten varieties: Mozat, Icrixina, Petomech and Gaytayeah-2 were very susceptible to BWT and died before flowering. Therefore, these mentioned varieties were not included in the further screening.

Four inorganic pesticides were evaluated using manufacturers' recommendation rates, applied a day before transplanting and repeated after 14 day while leaving the control plots unsprayed. Symptoms of BWT were observed on susceptible varieties two weeks after crop establishment and recorded in all plots. Five treatments were used in the experiment. Table 2 below show the lists of inorganic pesticides with their corresponding active ingredients and sources.

Data collected include: incidence and severity of BWT, insect pest damage, nutrients deficiency, total yield as well as other diseases identified. Disease severity was scored based on visual assessment, whereas disease incidence was calculated using the formula given by Getachew *et al.* (2011) as percentage plants showing symptom of disease.

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

Total yield per variety was determined by the weight of fruit harvested from 5 plants excluding the border rows. While 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 12$^{th}$ edition (Genstat, 2013). Treatment means was separated by LSD at 5 % probability.

## RESULTS AND DISCUSSION

Results presented in Table 3on the influence of varieties on plant height at 50% flowering showed significant difference (P<0.05) between Boufolo (87.4 cm) and the rest of the tomato varieties. However, there were no significant differences (P>0.05) among: Quibo,

**Table 1:**Tomato varieties and their origin

| No. | Variety | Origin | No. | Variety | Origin |
|---|---|---|---|---|---|
| 1 | Quibo | Ghana | 6 | Boulofo | Cot'divore |
| 2 | Mozat | Ghana | 7 | Petomech | Guinea |
| 3 | Bonanza | Ghana | 8 | Balia-1 | Liberia |
| 4 | Nimba-1 | Liberia | 9 | Gaytayeah-1 | Liberia |
| 5 | Icrixina | Mali | 10 | Gaytayeah-2 | Liberia |

**Table 2:** Inorganic pesticides and their active ingredients

| Inorganic pesticides | Active ingredient | Company/Country |
|---|---|---|
| Ivory 80 WP | Mancozeb 800/ kg | Ivory coast |
| Contizeb 85% WP | Mancozeb 80%+Manganese Ethylene Bisdithio Carbamate | Wenhzou-Wehe/China |
| D-Lion Fungi 2020 | Copper Hydroxide 77 % | Sino Agri-Bioscience/China |
| Azoxystrobin | Thiadiazole Copper | Zhejiang/China |

**Table 3:** Influence of varieties on plant height at 50% flowering, incidence of diseases and total fruit yield.

| Varieties | Plant Height at 50% Flowering | Incidence of Disease (%) | Total Fruit Yield |
|---|---|---|---|
| Quibo | 48.1c | 52.6a | 138.3c |
| | 53.5bc | 68.8a | 122.1c |
| Bonanza | | | |
| Nimba-1 | 50.4bc | 0.0c | 4399.5a |
| Boufolo | 87.4a | 23.7b | 1072.9b |
| Balia-1 | 58.9b | 52.5a | 1006.3b |
| Gaytayeah-1 | 52.3bc | 0.0c | 3926.4a |

Within a column figures followed by similar letters are not significant different at LSD 5%.

Bonanaza, Nimba-1and Gaytayeah-1.There was significant differences (P<0.05) between Balia-1and Quibo. Also there were no significant differences (P>0.05) among Bonanaza, Nimba, Balia and Gaytayeah. The difference in plant height at 50% is in confirmation with Shushay and Haile (2014) who obtained wide difference (62.1-105.3 cm) among nine tomato varieties evaluated in the Western lowland of Ethiopia of Tigray, Northern Ethiopia.

The incidence of BW disease on varieties was similar for Nimba-1 and Gaytayeah-1 (0.0%) but significantly lower than the other varieties.

This was followed by Boufolo with 23.7% disease incidence which was also significantly lower than the other varieties which showed similar disease incidence. Boufolo has some resistance genes similar to Nimba-1 and Gaytayeah-1.However, Bonanza recorded significantly higher (68.8%) incidence followed by Quibo (52.6%) and Balia-1 52.5% respectively. Statistically, there were no significant differences (P<0.05) among the three tomato varieties: Bonanaza, Quibo and Baliai1 but there were significant differences among them and rest of the varieties .The difference in the degree of BW incidence among varieties of tomato could be due to the differences in the genetic makeup of tomato genotypes as reported by Bediako *et al.* (2017) who screened 36 tomato varieties for resistance to tomato yellow leaf curl virus disease (TYLCVD) and identified variations in incidence level among varieties.

Impacts of varieties on total fruit yield, these varieties (Nimba-1 and Gaytayeah-1) were similar but significant higher than the remaining varieties. Though, there were no significant difference in fruit yield between Boufolo and Balia-1 they gave significantly higher yield than the rest of the varieties.

They were also the second high yielding varieties next to Nimba-1 and Gaytayeah-1. Quibo and Bonanzahad the lowest fruit yield which were similar but significantly different (P<0.05with the remaining varieties. The variations in yielding ability exhibited by tomato varieties in the trial with regards to good and bad fruits could be attributed to the number of flowers set that developed into fruits and reserved by the crop till harvest for consumption. The finding is similar to the finding of

**Table 4:** Effect of treatment on plant height at 50% flowering, incidence of diseases and total fruit yield.

| Treatment | Plant Height at 50% Flowering | Incidence of Disease (%) | Total Fruit Yield |
|---|---|---|---|
| Ivory 80% WP | 56.9a | 36.4a | 1589a |
| Contizeb 85% WP | 61.6a | 25.9a | 2051a |
| Di-Lion Fungi 2020 | 58.8a | 34.5a | 1659a |
| Azoxysrobin | 54.6a | 35.7a | 1604a |
| Control | 60.3a | 32.1a | 1985a |

Within a column figures followed by similar letters are not significant different at LSD 5% .

**Table 5a:**Effect of variety and treatment interaction on disease incidence.

| | Treatments | | | | |
|---|---|---|---|---|---|
| **Varieties** | **Ivory 80% WP** | **Contizeb 85% WP** | **D-Lion Fungi 2020** | **Azoxystrobin** | **Control** |
| Quibo | 55.5 | 48.1 | 48.1 | 59.1 | 51.8 |
| Bonanza | 66.6 | 59.2 | 74.0 | 77.7 | 66.6 |
| Nimba-1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Boufolo | 29.6 | 14.8 | 25.9 | 22.2 | 25.9 |
| Balia-1 | 66.6 | 59.2 | 59.2 | 55.5 | 48.1 |
| Gaytayeah-1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| LSD0.05 Variety*Treatment: 30.3 | | | | | |

**Table 6:** Effect of variety and treatment interaction on total fruit yield.

| | Treatments | | | | |
|---|---|---|---|---|---|
| **Varieties** | **Ivory 80% WP** | **Contizeb 85% WP** | **D-Lion Fungi 2020** | **Azoxystrobin** | **Control** |
| Quibo | 45 | 0 | 119 | 110 | 417 |
| Bonanza | 168 | 174 | 56 | 140 | 72 |
| Nimba-1 | 4887 | 4701 | 3524 | 3787 | 5098 |
| Boufolo | 857 | 1858 | 1024 | 674 | 952 |
| Balia-1 | 679 | 1575 | 1310 | 831 | 637 |
| Gaytayeah-1 | 2899 | 3999 | 3918 | 4080 | 4736 |
| LSD0.05 Variety*Treatment: 1370 | | | | | |

**Table 5b :** Correlation coefficient relating plant height at 50% flowering, incidence of diseases and total fruit yield.

| | Incidence of diseases | Plant height at 50% flowering |
|---|---|---|
| Plant height at 50% flowering | -0.0760 | |
| Total fruit yield | -0.7633*** | -0.1277 |

*** *P< 0.0000*

Gongolee *et al.* (2015) who mentioned similar noticeable difference in fruit yield of tomato varieties.

Plant height, incidence of disease and total fruit yield were not affect by treatments (Table 4).

Probably the pesticides or the dosage used was not adequate enough to the control the disease.

Varieties and treatment interaction on BW incidence is presented in Table 5a.

The two local varieties; Nimba-1 and Gaytayeah-1 showed significantly lower incidence rates (0.0%) than all the other varieties but similar to Boufolo. Boufolo and Quibo showed similar disease incidence. The low incidence rates recorded were probably responsible for some level of resistant genes against the pathogen *Ralstoniasolanacerum.*

The results of the finding with respect to the local varieties being resistant is similar to that of Aslam *et al*.(2017) who screened 30 tomato germplasm against bacterial wilt disease and found that two cultivars (Early King and Lerica) were resistant and four (Red Hero, Giant Cluster, Red Ruby and Red Stone) were moderately resistant while two cultivars (bonny Best and Roma VF were highly susceptible to the disease. However, there were significance differences ($p<0.05$) among them and the remaining varieties: Quibo, Bonanza and balia-1could be due to susceptible genes.

Nimba-1 interacted with all the pesticides including Control to the give the highest fruit yield. This was similar to Gaytayeah interacting with all the pesticides except Ivory 80% WP. This indicates that Nimba-1 has the full genetic potential of high yielding ability despite of pesticides application. Also Gaytayeah-1 recording the highest (4,736) total fruit yield in control plots similar to all treatments used and the variety is next to Nimba-1in terms of yield. However, Boufolo and Balia-1recording the highest (1,858 and 1,575) total fruit yield in Contizeb 85% WP similar to Nimba-1 and Gaytayeah-1. There were significant differences (P<0.05) among Contizeb 85% WP and the remaining treatments. Balia-1 and Boufolo recording the highest fruit yield in Contizeb 85% WP, could possibly be due to varieties differences. There were no significant differences (P>0.05) in the total fruit yield in treatments applied to Quibo and Bonanza. They recorded similar low yield in all the treatments mentioned in table 4 above.

The results showed indicate that there is strong correlation between disease incidence and the total fruit yield. That is the higher the disease incidence the lower the total fruit yield. The results support the findings of Guji *et al*. (2019) who compared growth, yield and disease incidence in ginger varieties at jimma, Ethiopia, during 2017 major cropping season and found that for each unit increase in percent of final mean wilt incidence, there was a rhizome yield reduction. Therefore, all diseases associated parameters had a negative effect on yield parameter. Bacterial wilt disease considered one of the devastating plant diseases affecting solanaceare crops should be addressed adequately through the use of resistant crop varieties and other best management practices.

## CONCLUSION

This comparative assessment of tomato varieties and pesticides against bacterial wilt disease of solanaceae family help us to fully identify the most resistant, susceptible, potential high yielding varieties and the efficacy of pesticides. Two of the 10 varieties both local Nimba-1and Gaytayeah-1 gave higher yield (4399.5 and 3826.4), also with low (0.0%) incidence rates. The higher (68.8%) incidence rate of BW and low yield was recorded for Bonanza an exoticvarieties. From crop protection perspective, the findings of the experiment indicated that BW disease is a major threat to tomato production in Liberia. None of the four pesticides control BW therefore,the use of resistantvarieties is the only best option for controlling bacterial wilt disease.

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