

SCREENING OF SOME IRISH POTATO VARIETIES FOR RESISTANCE TO TUBER SOFT ROT CAUSED BY *ERWINIA CAROTOVORA* SSP. *CAROTOVORA*

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ABSTRACT

Soft rot of potato tubers caused by *Erwinia carotovora ssp. carotovora* (Ecc) is a major threat to profitable potato production wherever the crop is grown. Five potato tuber varieties (Patista, Marabel, Christian Lady, Nicola and Caruso) were screened for resistance to soft rot in Dadin-Kowa of Gombe State, Nigeria. Artificially wounded and inoculated potato tubers of each variety were incubated under the anaerobic condition for 3 days and dump condition for 15 and 30 days. The trial was set up in a Completely Randomized Design (CRD) with four replications. Resistance was assessed based on tuber soft rot disease incidence and severity. The results showed that all the potato varieties expressed a similar trend of response to tuber soft rot irrespective of incubation conditions and durations. Caruso and Marabel expressed high and moderate resistance respectively while Christian Lady and Nicola were highly susceptible to soft rot. Caruso and Marabel were therefore recommended to farmers for effective management of the disease both in transit and storage. There is a need to incorporate resistance in Nicola been the most commercially cultivated variety but highly susceptible to soft rot.

Keywords: Disease incidence, disease severity, Irish potato tubers, management, soft rot,

INTRODUCTION

Irish potato (*Solanum tuberosum* L.), belonging to the family *solanaceae*, is a seasonal tuberous crop cultivated under low temperature worldwide. It ranks seventh world's largest and valuable food crop after rice, wheat, soybeans, tomato, sugarcane and maize (FOASTAT, 2017) contributing significantly to the staple food need in many developing countries and ensuring food security (Ndor, 2013). Potato tubers are important source of carbohydrate, minerals, vitamins and protein (FSA, 2002) consumed in a variety of dishes such as porridge, chips, boiled, etc. In Nigeria, Irish potato is mainly cultivated by poor resource peasant farmers on the plateau and also marketed by many poor people across the country that both depend on it as their major means of livelihood.

Soft rot of potato tubers caused by *Erwinia carotovora ssp. carotovora* (Ecc) is a major threat to profitable potato production wherever the crop is grown. The disease is however more devastating in Nigeria and other developing countries due to unavailability of conducive storage facilities. After harvest,

potato tubers are packaged in sacks and transported to different parts of the country (Bdliya and Abraham, 2010). The disease is considered economically important due to its ability to attack tubers before and during harvest, in transit and storage (Bdliya and Haruna, 2007) by secreting pectolytic enzymes which degrade cell wall and digest plant tissues hence, leading to decay (Ndivo *et al.*, 2018). Over 40% tuber losses in transit and storage have been reported in Nigeria (Bdliya and Dahiru 2006) and 20-60% loss was reported in Kenya (Thabèt *et al.*, 2013). Poor handling during harvest and transit as well as a high temperature of about 32°C could increase yield losses to 90-100% (Manzira, 2011).

To manage tuber soft rot, several works have reported the use of different methods including chemical treatments (Chen and Lin, 2000; Abd-El-Khair 2004; Wright *et al.*, 2005; Rahman *et al.*, 2017), physical treatments (Bdliya and Haruna, 2007) and plant extracts (Bdliya and Dahiru, 2006; Bdliya and Abraham, 2010; Amodu and Akpa, 2014; Ndivo *et al.*, 2018). Due to deleterious effect posed by

chemicals on the environment and partial success obtained from the application of plant extracts, host plant resistance remains the most effective, cheaper and eco-friendly management measure for tuber soft rot, especially in developing countries. Therefore, some potato cultivars commonly cultivated by farmers in the northern part of Nigeria were screened for resistance to tuber soft rot with Caruso as a check.

MATERIALS AND METHODS

The experiments were conducted in April and September 2019, in the Plant Pathology Laboratory, Department of Horticulture, Federal College of Horticulture Dadin-Kowa Gombe state of Nigeria.

Potato Tuber Source

Mature potato tubers of Patista, Marabel, Christian Lady, Nicola and Caruso (as Check) varieties were obtained from National Root Crop Research Institute Kuru out-station Plateau State where the bulk of its production lies in Nigeria. These varieties were selected based on their high yielding quality, all year round cultivation, farmers/consumers preference and paucity of documented information on their resistance status to soft rot disease in the country (FMARD, 2017). A total of 3600 (720 per variety) apparently healthy and uniformly medium-sized tubers were washed with tap water prior to the onset of the experiments.

Preparation of Inoculum and Tuber Inoculation

Ecc was isolated from potato tubers expressing soft rot symptoms using the semi-selective medium technique as described by Bdliya and Langerfeld (2005a) which was used throughout the experiments. The bacteria were preserved on nutrient agar (NA) slants at 4°C till required. Prior to inoculation of tubers, the bacteria were grown on NA plates for 48 h at 27±2°C. The plate cultures were suspended in sterile distilled water and the bacterial concentration adjusted to 10⁹ cells/ml by measuring the optical density (OD) at 650 nm using Spectrophotometer (Bausch and Lomb Illinois USA). Before inoculation, the tubers were surface sterilized in 10% sodium hypochlorite solution for 3 minutes. The

sterilization was followed by rinsing in three changes of sterile tap water. Tubers were dried at room temperature (about 37±1°C on April, 28 ±1°C in September). The tubers of each variety were wounded at the depth of 5cm with a sterile forceps and then artificially inoculated separately by submergence in the bacterial suspension for 30 minutes and thereafter were dried at room temperature for another thirty minutes.

Experimental Set-Up

In the first experiment, thirty inoculated tuber samples of each variety were placed in surface-sterilized plastic containers (about 40 x 40 x 10 cm) with moist tissue paper placed at the bottom to maintain high humidity (> 80%) within the containers and covered with lids. The containers holding the tubers were arranged and incubated for three days at 30±2°C in an incubator in the laboratory. The same number of inoculated tuber samples for each variety was used for the second and third experiments where tubers were kept under dump conditions (on sterilized laboratory bench) and incubated at 29±1°C and 28±2°C for 15 and 30 days respectively. All the three experiments were set up in a completely randomized design and replicated four times. The evaluation was based on the incidence and severity of tuber soft rot. Disease incidence (DI) was determined by counting the number of infected potato tuber expressed as a percentage of the total number of tubers observed. The severity of tuber soft rot was assessed on a scale of 0–5 as described by Bdliya and Langerfeld (2005b) where:

- 0 – no symptom of rot
- 1 – 1–15% of tuber rotten
- 2 – 16–30% of tuber rotten
- 3 – 31–45% of tuber rotten
- 4 – 46–60% of tuber rotten
- 5 ≥ 61% of tuber rotten.

The severity was then computed using the formula:

$$S = \frac{\sum n}{N \times 5} \times 100$$

where:

S – severity of tuber rot

(%) $\sum n$ – the sum of individual ratings

N – total number of potato tubers assessed
5 – highest score on the severity scale.

The resistance level was determined using the scale described in table... below

Table 1: Scale for Disease Resistance (%)

Resistance level rating	Disease percentage
Highly resistant	0 - 15.9
Moderately resistance	16 – 30.9
Moderately susceptible	31 – 45.9
Highly susceptible	≥46

Data Analysis

The mean data of the two months was computed for each parameter and subjected to analysis of variance. The difference in mean was compared using either least significant difference (LSD) or plotting standard error of means at 5% level of probability as described by Gomez and Gomez (1984).

RESULTS

The results showed that there was a significant difference ($P < 0.05$) among the treatments on the incidence and severity of potato tuber soft rot disease inoculated and incubated under the anaerobic condition for three days at $30 \pm 2^\circ\text{C}$. The lowest disease incidence (4.0%) was recorded from Caruso followed by Marabel (40.0%) while C. Lady had the highest disease incidence (98.7%). Disease severity followed a similar trend to that of disease incidence (Fig. 1).

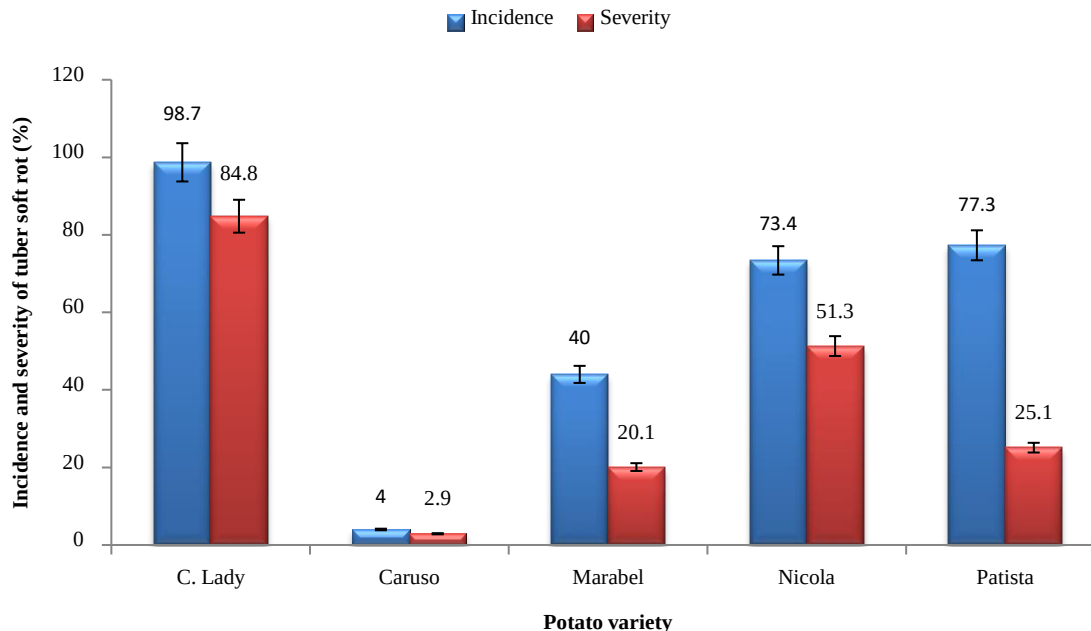


Fig.1. Effect of variety on the incidence and severity of potato tuber soft rot disease. Tubers were wounded, inoculated and incubated for three days at $30 \pm 2^\circ\text{C}$. Bars indicate standard error of means at 5% probability level.

The results in Figure 2 showed that there was a significant difference ($P < 0.05$) among the treatments on the incidence and severity of potato tuber soft rot disease inoculated and incubated under dump condition for fifteen days at $29 \pm 1^\circ\text{C}$. Caruso variety had the lowest disease

incidence (1.2%) which was followed by Marabel (25.4%) while the highest incidence (98.7%) was recorded from C. Lady. Similar trend of results was also observed on the disease severity.

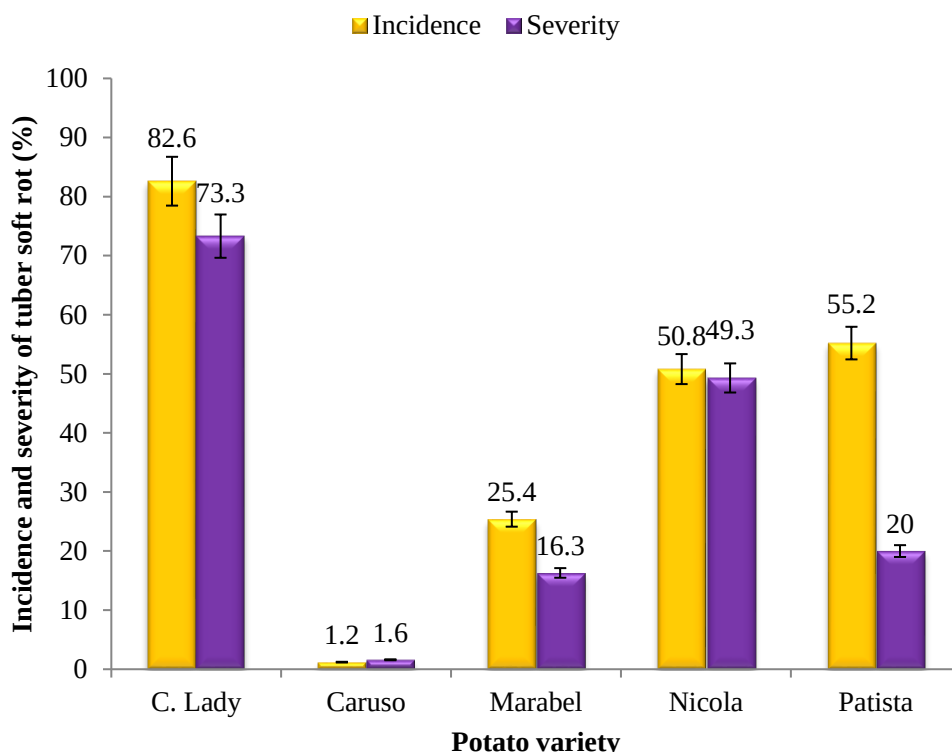


Fig. 2. Effect of variety on the incidence and severity of potato tuber soft rot disease. Tubers were wounded, inoculated and kept at dump condition for fifteen days at room temperature ($29 \pm 2^\circ\text{C}$). Bars indicate standard error of means at 5% probability level.

There was a significant difference ($P < 0.05$) among the treatments on the incidence and severity of potato tuber soft rot disease inoculated and incubated under dump condition for thirty days at $28 \pm 2^\circ\text{C}$. Caruso variety had the lowest disease incidence (2.7 %) which was followed by Marabel (30.4%) while the highest incidence (90.5%) was recorded from C. Lady.

Similar trend of results was also observed on the disease severity (Fig. 3). Caruso was highly resistant, Marabel was moderately resistant, Patista was moderately susceptible while Christian Lady and Nicola expressed high level of susceptibility to tuber soft rot (Table 2).

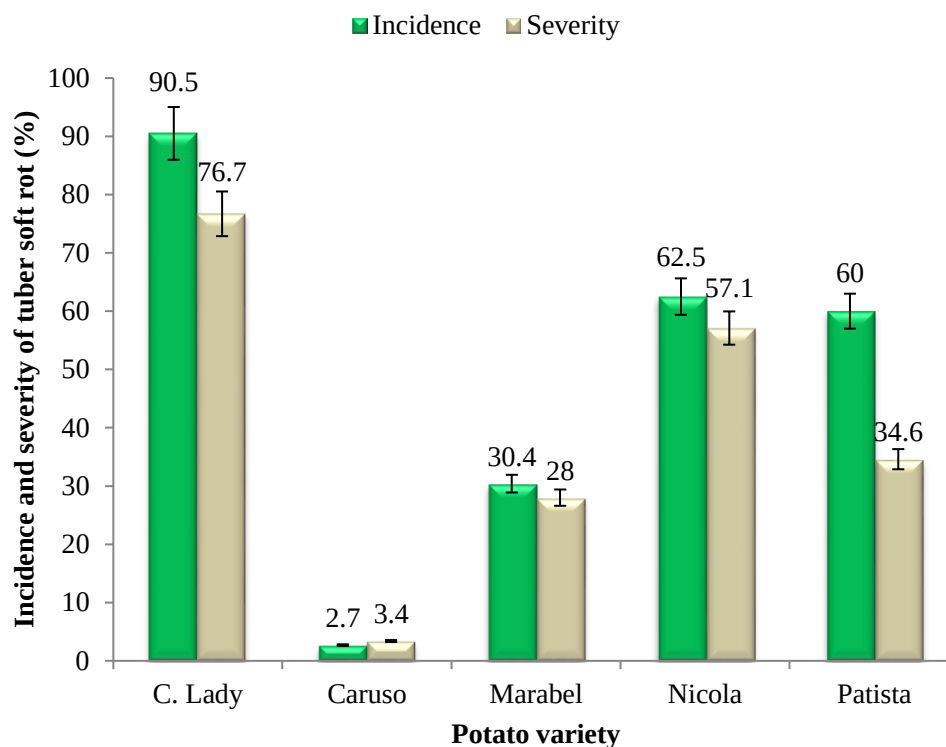


Fig. 3. Effect of variety on the incidence and severity of potato tuber soft rot disease. Tubers were wounded, inoculated and kept at dump condition for thirty days at room temperature ($28 \pm 2^\circ\text{C}$). Bars indicate standard error of means at 5% probability level.

Table 2: Response of potato varieties screened for resistance to tuber soft rot

Potato variety	Resistance category
Christian Lady	Highly susceptible
Caruso	Highly resistant
Marabel	Moderately resistant
Nicola	Highly susceptible
Patista	Moderately susceptible

DISCUSSION

All the potato varieties expressed a similar trend of response to tuber soft rot irrespective of incubation condition and duration. Tubers of each variety were wounded and exposed to uniform concentration and duration of *Ecc* inoculum thereby eliminating all chances of disease escape. The study reveals that tuber soft rot incidence and severity was generally higher under anaerobic condition compared to aerobic condition. The significantly higher soft rot incidence and severity observed under anaerobic condition compared to aerobic condition might be due to the negative effect of anaerobic condition on potato tuber disease resistance mechanisms. The role of anaerobiosis

in impairment of oxygen-dependent active or induced disease resistance systems (Phenolics, phytoalexins, suberization, lignification) in potato tubers to *Ecc* have been reviewed by

Pérombelon (2002). However, some potato tuber varieties have been reported to be resistant to *Ecc* under anaerobic conditions (Williams *et al.*, 1990; McMillan *et al.*, 1993). There were variations among the varieties screened on response to soft rot with Caruso and Marabel been highly and moderately resistant respectively while Christian Lady and Nicola were found to be highly susceptible. Genetic and phenotypic factors could have influenced the varietal responses to the disease since they are exotic varieties and mainly developed for high

yielding quality. These findings were in agreement with an earlier report of Hamid and Bilal (2018) who documented that there were variations in the response of fifty-nine potato cultivars either to natural infection or to artificial inoculation. High and moderate resistance expressed by Caruso and Marabel respectively further confirmed the observation of a potato farmer (D. Bako, pers. commun., 2019) on Jos plateau. Wright *et al.* (2005) have reported the effectiveness of cultivar on the management of soft rot in potato. Vanderplank and Pentland Dell potato cultivars from South Africa have been reported to be most effective on the management of tuber soft rot among other cultivars screened for resistant to the disease (Ngadze *et al.*, 2012). Rapid death of the wounded tissues invaded by Ecc which restricts its further colonization was observed to be the mechanism of resistance in Caruso and Marabel tubers. Several works have reported the role of some compounds such as polyphenol oxidase, peroxidase, phenylalanine ammonia lyase, chlorogenic acid and pectin esters in potato cultivars observed to be resistant to soft rot even under anaerobic condition (Ghaneka *et al.*, 1984; Kumar *et al.*, 1991; Lojkowska and Holubowska, 1992; McMillan *et al.*, 1993; Ngadze *et al.*, 2012).

CONCLUSION

It was concluded from this study that the five potato varieties screened showed varying responses to tuber soft rot. Caruso and Marabel expressed high and moderate resistance respectively while Christian Lady and Nicola were highly susceptible to soft rot. Caruso and Marabel are therefore recommended to farmers for effective management of the disease both in transit and storage. There is a need to incorporate resistance in Nicola being the most commercially cultivated variety but highly susceptible to soft rot.

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