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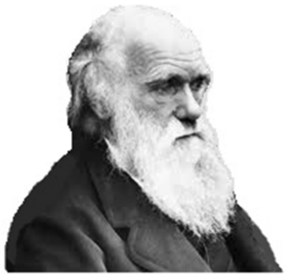

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Performance evaluation of potato varieties under aeroponics conditions in Rwanda

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ABSTRACT

Potato (*Solanum tuberosum* L.) is an important food and cash crop in Rwanda. The objective of this study was to identify suitable potato varieties for growing under aeroponics production systems. Four commercial potato varieties - Kirundo, CIP 393371-58, Kinigi and Kigega - were evaluated in an aeroponics green house at Rwanda Agriculture Board RAB-Musanze station, from January to May 2016. The study consisted of 30 plantlets per m^2. The experimental design was a split plot design with four replications. In an enclosed environment, the supply of nitrogen (N), phosphorus (P), magnesium (Mg), calcium (Ca), and other nutrients to plants were done by use of a mist nebulizer. The results showed there was an increased vegetative cycle in CIP 393371-58 (with 8.2 cm plant height and 3.3 nodes) followed by Kirundo (1 cm plant height and 1.5 nodes), Kinigi (27.1 cm plant height and 6.2 nodes) and Kigega (56.4 cm height and 19.3 nodes), respectively. The maturity period of CIP 393371-58 was 70 days. This was earlier than Kinigi (77 days), Kirundo (112 days) and Kigega (156 days), respectively. The mini-tuber per plant production was also higher in CIP 393371-58 (41), followed by Kinigi (36), Kirundo (28) and Kigega (7), respectively. The data showed that the CIP 393371-58 variety was better adapted to an aeroponics environment than were Kinigi, Kirundo, and Kigega, respectively.

***Keywords*:** Potato varieties, mini-tubers, aeroponics, yield

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1. INTRODUCTION

The potato (*Solanum tuberosum* L.) is a major world food crop, next in production only to maize, rice and wheat. It belongs to order *Solanal*, family *Solanaceae*, genus *Solanum* and species of *tuberosum with chromosome number 2x = 48*. Research into Use (RIU) identified potatoes as key crop due to the fact that demand is high, farmers earn money from them and support Rwanda's food security. Potatoes are country's second energy source after cassava where its annual consumption is assumed to be at 125 kg per person per year also potato are said to be high potential food security crop due to its ability to provide high yield of quality product per unit input with a short crop cycle (around 120 days).

In Rwanda, the potato came with German soldiers and Belgian missionaries in the early 20th century and is the second main food crop after banana and its significance is escalating. Productivity of potato is 12 mt/ha, with potential productivity 40 mt/ha. Common potato diversities produced in Rwanda comprise: Kinigi, Kirundo, Mabondo, Cruza and Sangema and many others, however; production of the irish potato is still low in the country. The real cause of this low yields production include the use of low quality potato seed, poor disease management (late blight caused by *Phytophthora* infestans and bacterial wilt caused by bacteria, early bright caused by *Alternaria solani*, seed degeneration caused by the viruses and mycoplasma) and inadequate soil fertility management [1, 2]. Use of soil-less seed production system was introduced to reduce seed born disease infections such as use of Aeroponics system [3]. Aeroponics system in rapid multiplication of potato seed can be used to produce high yields up 10 times more than traditional method as well as reduce infection rate of soil based disease [3]. In Aeroponics plant roots grow in the air, tuber contact with soil-borne pathogens is avoided, and production per plant increase considerably [4]. Response to Aeroponics system is variety (cultivar) dependent due to their genetic make-up difference [3]. This study was conducted to assess the adaptability of potato varieties in Rwanda to the aeroponics system.

2. MATERIALS AND METHODS

Tissue culture planted of four commercial potato varieties (CIP 393371-58, Kinigi, Kirundo, Kigega) provided by Rwanda Agriculture Board (RAB). After acclimatization of plantlets from in vitro tissue culture were grown in sterilized sand trays for root development within around 15 days then transported to Aeroponics greenhouse for plantlets transplantation for plantlets transplantation. The underground parts of plant were enclosed in dark chamber and were supplied with nutrient solution through way of mist device. 252 g of potassium nitrate, 246 g of magnesium sulfate, 118 g of calcium nitrate, 68 g of potassium phosphate, and 6 g of fetrilon combi were dissolved in 10 liters of water to make the stock solution [3]. Then 10 liters of stock solution were diluted to make 500 liters of solution ready to use. The nutrient solutions were supplied to plant roots system by a 15 minute automatic timer pump and 15 minute for rest. Plants were lowered whenever necessary to allow better formation of stolons in each plant. Before any activity in which parts of plant is to be touched hands were disinfected using alcohol solution. Plantlets were evaluated under same plants densities in an Aeroponics greenhouse at RAB Musanze station. Where data collection were conducted in Aeroponics greenhouse of RAB-MUSANZE/NAZD, split-plot design in which randomized complete block with plant density (30 plants per m^2) in main-plots, one for each variety. Boxes which were used are constructed in such way to optimize the screen house space and four boxes of 4.8 m × 1.2m dimension each were used. Each box is divided into four sub-plots of 1.2 m × 1.2 m each. Aeroponics box having Wooden and Styrofoam sheets frame with windows at each side to facilitate harvesting. To drain out excess nutrient solution box slop toward a collection tank. Black plastic sheets were used for lining holes and covering the windows as double curtains to exclude light to the root system of the plants. Internal curtains were used to prevent the nebulized nutrients solution from drifting out of the Aeroponics system. The top Styrofoam cover of 1.2 m × 1.2 m each were holed into 30 holes and lining with PVC pipes.

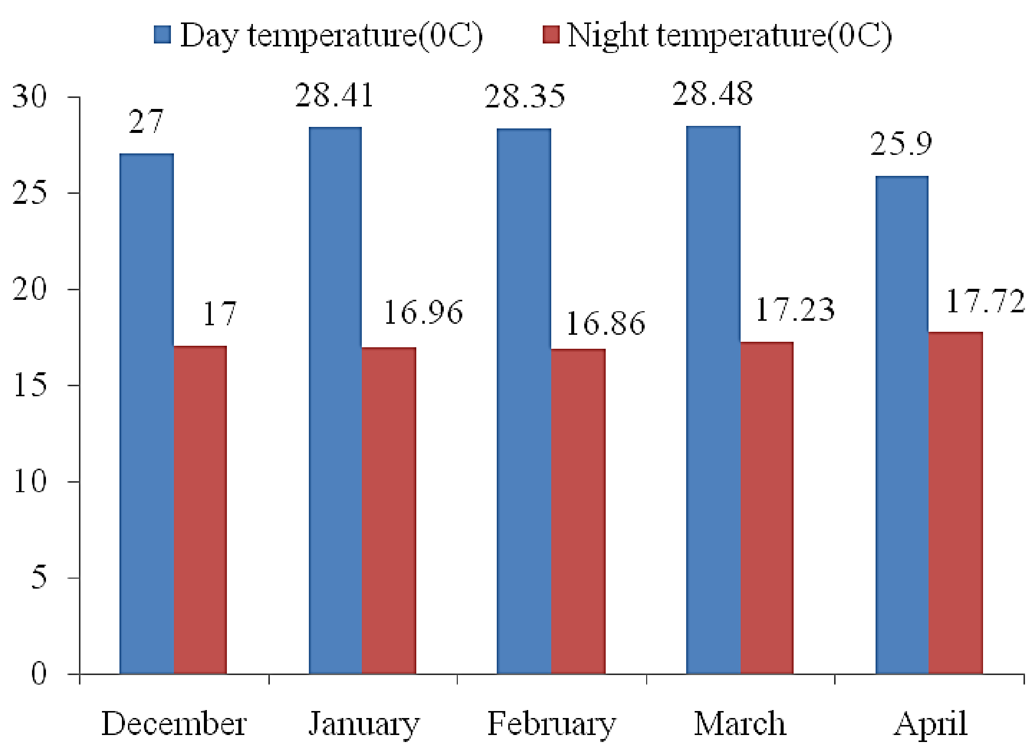

Figure 1. Average temperature recorded inside the greenhouse during potato growing period

3. RESULTS AND DISCUSSIONS

Data recorded illustrated the variation among varieties in such way that plants in CIP 393371-58 variety with mean of height found to be equal to 92.7 cm and mean of nodes found to be equal to 27.3 nodes were generally taller than Kinigi, Kirundo, Kigega. Plants in Kirundo Variety with mean of height found to be equal to 84.5 cm and number of nodes found to be equal to 24.0 nodes are taller than those Kinigi and Kigega. Plants in Kinigi variety with mean of height found to be equal to 83.5 cm and mean of height found to be equal to 25.5 nodes are taller than those of Kigega with 56.4 cm as mean of height and 19.3 nodes as mean of nodes at 3, 5, 7, 9, 11 and 13 weeks after transplantation (Table 1).

Table 1. Height of plantlets and number of nodes for four varieties within 13 weeks after transplantation.

Varieties	Parameters											
	Height						Number of nodes per plant					
	3 WAP	5 WAP	7 WAP	9 WAP	11 WAP	13 WAP	3 WAP	5 WAP	7 WAP	9 WAP	11 WAP	13 WAP
CIP 393371-58	10	52	90.5	126.2	138.8	138.8	8	15	26	33	41	41
Kinigi	8.9	47.9	85.8	110.9	123.8	123.9	7	12	23	27	30	30
Kirundo	8.6	45.2	80.0	108.5	130.7	134.1	7	11	21	30	36	39
Kigega	4.7	22.8	42.0	69.1	89.9	110.1	6	11	18	23	27	31
Mean	8.05	41.98	74.58	103.68	120.80	96.48	7	12.25	22	28.25	33.50	35.25
CV(%)	24.88	27.19	25.66	20.34	15.41	33.36	10.10	13.39	13.25	13.10	16.14	13.65
F test	NS	NS	NS	*	*	*	NS	NS	NS	*	*	*

WAP: Weeks after transplanting, * significant at 0.05 % level of significance, NS: non significant

Plants in Kigaga variety generally grow slower under aeroponics condition. The record demonstrated that CIP 393371-58 growth faster and mature earlier than other varieties, where it takes only 70 days before first harvest (days to maturity) after transplanting compare to that of Kinigi which require 77 days, Kirundo which require 112 days and Kigega which require 126.0 days to be mature (Table 1). Also those four varieties are differentiated on number of nodes where CIP 393371-58 had many number of nodes than other varieties, but on 3, 5, and 7 weeks after transplanting Kinigi had great number of nodes than Kirundo, at 9, 11 weeks after transplanting number of nodes of Kirundo were increased than number of nodes of Kinigi, Kigega had fewer number of among those varieties (Table 1). The yield of mini-tubers per plant are differently among those four varieties in CIP 393371-58 yielded 41 mini-tubers per plant, in Kinigi yielded 36 mini-tubers per plant, in Kirundo yielded 28 mini-per plant and in Kigega yielded 7 mini-tuber per plant (Table 2). According to Mateus Rodriguez et al [10] aeroponics technology is potentially efficient for specific potato cultivars, so varieties differ their response in aeroponics system.

Table 2. Significant difference between four varieties in their average of height, number of nodes, days to maturity and productivity.

Varieties	Average Height	Average number of nodes	Daysto maturity
CIP 393371-58	92.7	27.3	70.0
Kinigi	83.5	25.5	77.0
Kirundo	84.5	24.0	112.0
Kigega	56.4	19.3	126.0
Mean	79.28	24.03	96.25
CV%	17.27	13.32	24.33
F-test	*	*	*

* significant at 0.05 % level of significance

Data recorded illustrated the variation among varieties in such way that plants in CIP 393371-58 variety with mean of height found to be equal to 92.7 cm and mean of nodes found to be equal to 27.3 nodes were generally taller than Kinigi, Kirundo, Kigega. Plants in Kirundo variety with mean of height found to be equal to 84.5 cm and number of nodes found to be equal to 24.0 nodes are taller than those Kinigi and Kigega. Plants in Kinigi variety with mean of height found to be equal to 83.5 cm and mean of height found to be equal to 25.5 nodes are taller than those of Kigega with 56.4 cm as mean of height and 19.3 nodes as mean of nodes at 3, 5, 7, 9, 11 and 13 weeks after transplantation (Table 1). Plants in Kigaga generally growth slower under aeroponic condition. The record demonstrated that CIP 393371-58 growth faster and mature earlier than other varieties, where it take only 70 days before first harvest (days to maturity) after transplanting compare to that of Kinigi which require 77 days, Kirundo which require 112 days and Kigega which require 126.0 days to be matured (Table 2). Also those four varieties are differentiated on number of nodes where CIP 393371-58 had many number of nodes than other varieties, but on 3, 5, and 7 weeks after transplanting Kinigi had great number of nodes than Kirundo, at 9, 11 weeks after transplanting number of nodes of Kirundo were increased than number of nodes of Kinigi, Kigega had fewer number of among those varieties (Table 2). The yield of mini- tubers per plant are differently among those four varieties in CIP 393371-58 yielded 41 mini-tubers per plant, in Kinigi yielded 36 mini-tubers per plant, in Kirundo yielded 28 mini-per plant and in Kigega yielded 7 mini-tuber per plant. Rolot and Seutin [6] reported that the final mini-tuber yield is dependent on the cultivar used where as Victorio et al [7] suggested environmental play the role. Our findings gave significantly higher yields than those found by [8] with 13, and Ritter et al. [9] with 12.4 mini-tubers per plant, respectively but only Kigega minituber per plant is low, However using cultivars adapted to the obtained yields of up to 70 mini-tubers per plant at Peruvian Andean highlands reported by [3].

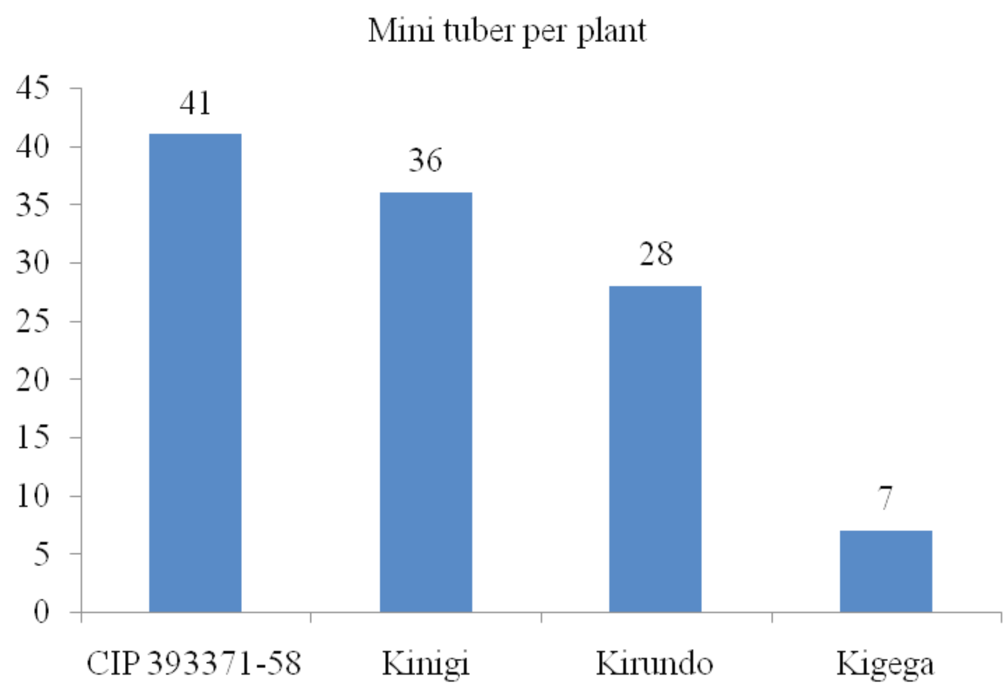

Figure 2. Production (mini tuber/plant) of different potato varieties

4. CONCLUSION

Based on results of this study, it can be concluded that that CIP 393371-58 variety was more adapted and productive in the aeroponics environment than Kinigi, Kirundo and Kigega. Response under aeroponics is cultivar dependent and requires testing more varieties to select the most adapted for production in this system.

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