Bitter Melon (*Momordica charantia* L.) in Barbados: Assessing the Effects of Nitrogen and Potassium Fertilizers on Plant Growth and Anti-Diabetic Properties

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(left to right: Dominique Souris, Dr. Winston Tinto (Biochemistry professor at UWI, Cavehill campus), Vivien Underdown, Dr. Rajendra Maurya (mentor) and Sarah Fioravanti, at the garden of the University of the West Indies (UWI), Cave Hill, Barbados.

Introduction- Bitter Melon

- Also known as karela, carailli, cerasee, balsam pear, and bitter gourd
- Distribution: India, China, Malaysia, the Philippines, Thailand, the Amazon, East Africa, South America and the Caribbean.
- Health benefits: It is used as an antioxidant, antimicrobial, antiviral, and antiulcerogenic. It is also particularly used in the treatment of Type II Diabetes; over 100 studies ascertain its ability to lower blood glucose levels.

Relevance in Barbados

Diabetes

- Affects 18.86% of the adult Barbadian population (diagnosed and undiagnosed), compared to 8.3% of the global population (International Diabetes Federation, 2012).
- Approximately 200 major and minor limb amputations in Barbados a year (Gill, 2009), and costs the country upward of USD 1,140.40 per person with diabetes in 2012.
- Recent survey conducted in Barbados (Peter, 2013) suggests the potential for greater consumption of bitter melon on the island since there is a prominent use of traditional medicine, in particular *Momordica charantia* L., as a replacement for therapy suggested by medical practitioners for diabetes.

Goals and Objectives

1) Determine the concentrations of inorganic fertilizers (different concentrations of nitrogen and potassium fertilizer were assessed with a constant phosphorus concentration) needed for optimal fruit production in local soil.
2) Evaluate the plant's medicinal use (i.e. the concentration of vitamin C and Momordicin present in the fruit and leaves) and marketing potential.

This study aimed to provide the baseline necessary for future studies on the production, consumption and marketing of the bitter melon fruit in Barbados.

Materials and Methods

Fertilizer application

Five fertilizer treatments were established:

- T_1: control (no fertilizer addition)
- T_2: 70:25:25 NPK kg/ha
- T_3: 70:25:35 NPK kg/ha
- T_4: 80:25:20 NPK kg/ha
- T_5: 80:25:30 NPK kg/ha

- Research garden was divided length-wise into 3 replicates, with 5 plots each, in which the 5 treatments would be applied in each; this was to account for potential differences in sunlight and shading. Within each replicate, we used a simple random sampling without replacement method to assign fertilizer treatments.

The fertilizer treatment was divided into two doses. The first was applied on June 3, 2013: the full P dose, and half of the N and K dose each were scattered on each plot. The remainder of the fertilizer was applied 2 weeks later, on June 18, 2013.

Vegetative growth

Starting the first week of fertilizer application (June 3), observations of days to flowering and fruiting were documented. Observations occurred weekly on Mondays and Tuesdays, until July 29, 2013.

To examine the effects of the fertilizer on vegetative growth we used a simple random sampling without replacement method to select five plants per plot for which plant height, number of leaves per plant, and chlorophyll content were to be measured. Due to investigation time constraints, plant height and number of leaves (documented on June 4 and June 10) were not recorded again.

Bitter melon field, on May 28th

Bitter melon field, on August 20th

Chlorophyll content was also measured (on June 4 and July 29), using a Fieldscout CM1000, Reflectance Chlorophyll Meter (borrowed from Dr. Lopez, University of the West Indies).

Fruition and Fruit Quality

On July 15, 2013, 75 green mature fruit (typical of market produce) were picked to record fruit characteristics and to prepare samples for fresh and dry weight analysis. On July 16, the length (cm), diameter (cm), number of seeds, and fresh mass (g) of the fruit samples picked on July 15 were measured.

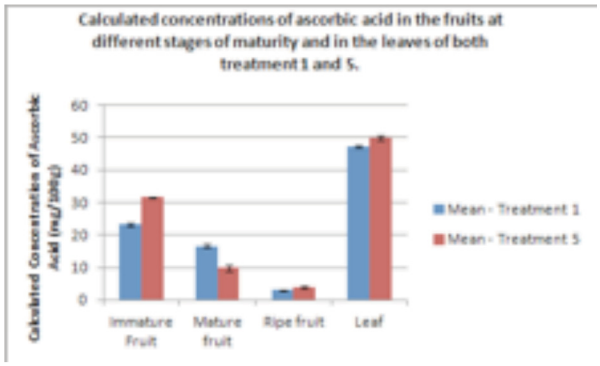
(left to right: different stages of growth- green immature, green mature, ripe, and dehiscent bitter melon fruits)

Titration

The determination of Vitamin C concentration by titration (Redox Titration Using Iodate Solution) was performed by the laboratory technician, Khadisha Moore.

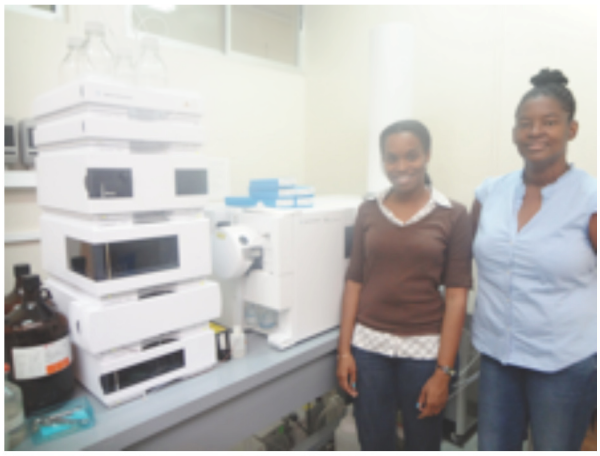
In order to prepare the samples for the titration, two fruits per plot per replicate (3 replicates per treatment) were collected for both treatment 1 and 5. Therefore, a total 6 fruits were collected randomly for each stage of growth.

Khadisha Moore, the laboratory technician, performing the titrations.



LCMS

On July 31, 2013, Dr. Joy Roach ran the liquid chromatography-mass spectrometry (LCMS) experiment for the 6 fruit samples (immature, mature, and ripe for both T1 and T5) using methanol as the solvent for the extraction. On August 2, 2013, Dr. Joy Roach ran the LCMS experiment for the leaves of T1 using methanol as the solvent for the extraction. In addition, she set up the fruit samples (immature, mature, and ripe for both T1 and T5) for the crude ethyl acetate extraction and the second methanol extraction. The samples rested for 120 hours, and the vials were kept at room temperature. This procedure allowed to detect the potential presence of Momordicin 1 and 28.



Khadisha Moore and Dr. Joy Ranch standing next to the LCMS machine.

Findings

There were significant differences between the mean values of ascorbic acid concentrations among the immature fruits, mature fruits, ripe fruits and leaves of the same fertilizer treatment, both for treatment 1 and 5. There was also a significant difference between the measurements of plant height performed of June 4 and June 10 for treatment 1. The presence of Momordicin was detected in both the ripe fruits of treatment 1 and 5 and in the immature fruits of treatment 5. However, no other significant difference was found for the other variables: chlorophyll content, fruiting, and fruit characteristics of the green mature fruits (diameter, length, fresh mass, and number of seeds).

Recommendations

- Further studies on optimal fertilizer ratios
- Quantifying Momordicin
- Socio-economic studies:
  - Methods and frequency of consumption
  - Developing recipes that do not reduce healthy components
  - Developing Partnerships

Acknowledgements

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As undergraduate students, we were limited in knowledge and experience pertaining to biochemical analyses. It is thus important to highlight that the analyses of Momordicin and Vitamin C conducted in this study were executed by Khadisha Moore, a recent graduate from the Biochemical Sciences Program at the University of West Indies, Cavehill Campus, under the supervision of Dr. Joy Roach and Dr. Winston Tinto from University of West Indies, Cavehill Campus. We would like to thank the aforementioned for their dedication and technical support. Without them, this project would have never been completed.

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