# Comparing the performance of a home-made bottle drip to a commercial drip system in the production of lettuce (*Lactucasativa L.*)

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***Abstract—*** *A study was conducted in which lettuce (Lactucasativa L.) was grown in a plot at the Faculty of Agriculture at Luyengo Campus of the University of Eswatini to compare three different irrigation methods on the production of marketable heads of lettuce. The performance of lettuce under a commercial drip tape was compared with a home-made bottle drip and a hand watering can as used typically by rural people in the country. The commercial drip had emitters discharging 2 liters per hour and therefore 2 liters per hour was applied with both the home-made bottle drip and the watering can during irrigation. The irrigation frequency was every after two days for all the treatments. The plot sizes were 1.5 m x 4.0 m and there were four replications per treatment. There were eighteen lettuce plants per plot. The lettuce was grown for a period of four weeks and then harvested whole. Yield parameters measured included the plant height (cm), leaf area index (LAI), root length (cm) and the fresh head mass (grams). Significant differences (P < 0.01) between treatments were obtained for fresh lettuce head mass and root length. The commercial drip treatment had largest fresh mass at 226.8 g. It was followed by bottle drip at 184.8 g. The control had the lowest yield at 165.3 g. There were no significant differences between treatments for plant height and leaf area index. It was concluded that the home-made bottle drip irrigation method could be recommended for rural people who cannot afford to buy the commercial drip system for the production of vegetables for household consumption.*

***Keywords— Lettuce, yield, drip, irrigation, water use efficiency.***

## I. INTRODUCTION

Eswatini import approximately 37,300 metric tonnes of fruits and vegetable with a value of US$11,000,000 from South Africa (NAMBOARD, 2018). This is because the annual rainfall distribution in the country is skewed, with the most rainfall 1,500 mm received in the Highveld region and the least 450 mm in the Lowveld region. The Lowveld is the ideal place for vegetable production, but due to lack of water, rural communities struggle to make ends meet.

Crop production can only be a success if grown under irrigated conditions. However, the energy requirement associated with irrigation makes its adoption difficult. The adoption of low energy agricultural technologies like drip in the country is very low, as the Eswatini government tends to promote conventional methods of water resource development as opposed to micro irrigation which is ideally suited to small holder farmers (Manyatsi and Magongo, 2008). Drip irrigation can be more efficient than sprinkler and furrow irrigation (Hunsaker et. al., 2019) since only the root zone of the cropped area is irrigated (Dukes et. al., 2006 and Hartz, 1999). Many of the soils where vegetables are grown are sandy with very low water holding capacities. These require frequent irrigation and fertigation to minimize crop stress and to attain maximum production. The main drawback with drip systems is the frequent emitter blockages (Zhou et. al., 2019)

Although drip irrigation can be very efficient at 90 percent since water and nutrients are delivered to the crop root zone, the capital cost is beyond the reach of most rural farmers. Also, mismanagement can lead to over irrigation and excessive nutrient loss due to leaching. The beneficial effects of drip irrigation management compared to other forms of water management are attributed to a uniform water application (Sandhu et. al., 2019), controlled root zone development and better disease management since only the soil is wetted whereas the leaf surface stays dry (Holmer and Schnitzler, 1997).

Since the capital cost of drip irrigation is beyond the reach of many rural farmers (Westarp et. al., 2004) including Eswatini, the bottle drip system offers a feasible option for economic production in areas of low rainfall or during periods of water scarcity. Drip irrigation refers to any system of watering cultivated crops in which the water is delivered directly to each individual plant on a gradual and continuous basis (Bajracharya and Sharma, 2005). A bottle drip system is an easy way of watering plants (Darouich et al., 2014), no costs is involved in purchasing the bottles as old material is useful, no power or piping required to supply the water and it’s very easy to make. The purpose of this study was to evaluate the effectiveness of two different methods of drip irrigation, namely commercial surface drip and the bottle drip method, on the growth performance and yield of lettuce grown at Luyengo, Eswatini.

## II. MATERIALS AND METHODS

In order to test the response of lettuce (*Lactucasativa L.*) to the method of water delivery by the commercial and bottle drip-irrigation systems, a field plot experiment using a split plot design was established in the Agricultural and Biosystems Engineering farm of the University of Eswatini at Luyengo campus. The farm is located in the Middleveld of Eswatini at $21^0$34′Sand $31^0$12′E at an altitude of about 730 m above sea level. The experiment consisted of three treatments (commercial and bottle drip) and a watering can which was the control. There were four replicates. The control treatment was irrigated with a normal 10 litre watering can as in the traditional practice in the rural areas.

Yield parameters measured at harvesting were plant height (cm), leaf area index (LAI), root length (cm) and the lettuce fresh mass (grams).

### 2.1 Commercial drip equipment

Sixteen millimetre (16 mm) non pressure compensation dripper lines were laid in plots that were four metres long. The drippers had emitters spaced 60 cm apart, each discharging about 2 litres of water per hour. The aim was to apply about 8 mm of water per irrigation per day.

### 2.2 Bottle drip equipment

Two litre cool drink plastic bottles with lids were used to store water and provide water to the lettuce plants. Small holes were drilled into the cap of the plastic bottles. The aim was to have a discharge from the holes of approximately 2 litres per hour. The bottom of each bottle was removed to enable the bottles to be filled with water easily and also collect rainfall water. A hole was dug next to each plant and the bottle buried approximately one-third deep with the bottom facing up.

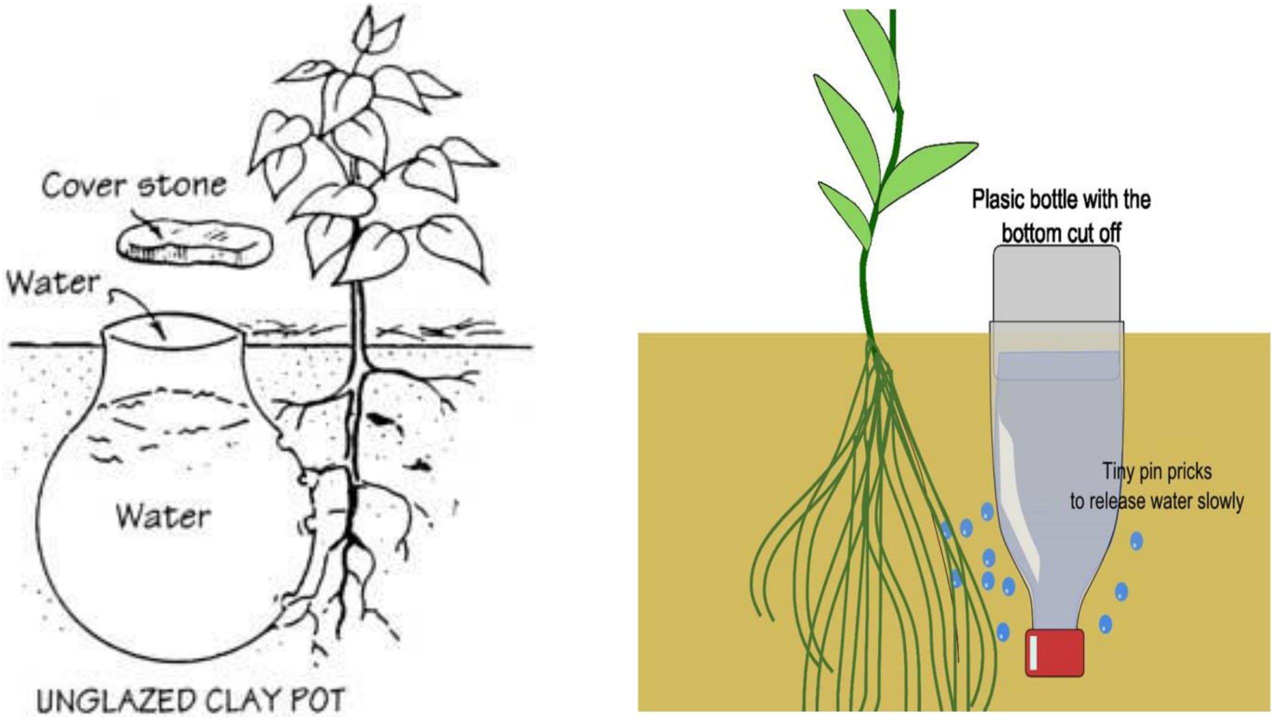


**FIGURE 1. The diagram on the left shows a clay pot used for irrigating crops in the olden days and on the right an example of bottle drip irrigation.**

### 2.3 Transplanting

Seedlings were obtained from Vickery Seedlings, a local company that supply ready to be planted seedling located at Malkerns. Basal fertilizer dressing was done using N:P:K; 2:3:2 (22) fertilizer at a rate of 50 g per seedling. The seedlings were planted directly under the emitter in the commercial drip system and 10 cm away from the bottle drip system. Irrigation was done every two days in all the treatments.

### 2.4 Water Management

Water application was done every two days in all the treatments. In the case of commercial drip system, a gate valve was opened during irrigation for about an hour to allow water to drip to the plants for an equivalent of 8 mm application. The bottle drips were filled with the equivalent of two litres of water for the same purpose.

## III. RESULTS AND DISCUSSION

### 3.1 Rainfall Data

Table 1 shows the amount of rainfall received during the duration of the experiment. There were only four rainy days, all within the month of March. The highest rainfall of 30.5 mm was received in the early part of the experiment on the 12th of March which was immediately after planting (11th March). The lettuce was planted on the 11th March and harvested on the 11th April.

**TABLE 1**
**THE AMOUNT OF RAINFALL RECEIVED DURING THE DURATION OF THE EXPERIMENT**

| Date of Rainfall | Rainfall Amount (mm) |
|---|---|
| 12-Mar-12 | 30.5 |
| 16-Mar-12 | 14.5 |
| 23-Mar-12 | 8.5 |
| 30-Mar-12 | 7.5 |
| **Total** | **61.0** |

From the 20th of March to the time of harvesting, the contribution of rainfall to the growth of the lettuce was negligible meaning that the conditions were ideal for irrigation.

### 3.2 Yield and growth parameters

Results of yield and growth parameters (plant height, leaf area index, fresh mass, root length) are summarised in table 2 below.

**TABLE 2**
**YIELD AND GROWTH PARAMETERS FOR THE LETTUCE EXPERIMENT**

| Treatment | plant height (cm) | leaf area index (LAI) | fresh lettuce mass (g) | root length (cm) |
|---|---|---|---|---|
| Control | 14.2 | 23.3 | 165.3 | 15.93 |
| Bottle drip | 15.0 | 26.1 | 184.8 | 14.78 |
| Commercial drip | 16.1 | 30.9 | 226.8 | 11.80 |
| Significance | **NS** | **NS** | ** | ** |

***Values showing ** stand for significant differences at $P < 0.01$ probability level, whereas NS represents a non-significant value.***

The yield and growth parameter results show that there were no significant differences in plant height and leaf area index obtained between the treatments. There were highly significant differences ($P < 0.01$) in the results for fresh lettuce mass and root length. The commercial drip treatment had the largest mass followed by the bottle drip treatment, with the watering can treatment (control) having the lowest mass.

Root length measurements shows that on average the watering can treatment (control) and the bottle drip had significantly ($P < 0.001$) longer roots compared to the commercial drip treatment.

## IV. CONCLUSION

It was concluded that the home-made bottle drip irrigation method could be recommended for rural people in Eswatini who cannot afford to buy the commercial drip system for the production of vegetables for household consumption.

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