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A Study on Hydroponic Farming System of Wheat, Spinach and Sword Lily for Sustainable Development of Agriculture

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ABSTRACT

The continuous augmented demand of food production is escalating with increase of world population. The traditional farming system will not be able to cover the world's emergent demand for food with rising pollution level and oscillations in climate. The design and development of new farming and planting system technique is urgent requirement to stay away from food catastrophe in future. The present study aimed to examine an efficient lab to land transfer technique for alternative agri-farming system, the hydroponic system. The *in vitro* data was evaluated and validated through numerical tools for comparative accounts between hydroponics and tap water system against *Triticum* sp. (Poales: Poaceae), *Spinacea* sp. (Caryophyllales: Amaranthaceae) and *Gladiolus* sp. (Asparagales: Iridaceae). The results showed that wheat, spinach and sword lily showed very good growth in Hoagland solution in comparison to tap water. Thus the field application of the proposed hydroponic system for cereals, vegetables and flowering crops will meet the world wide demand of today and future by sustainable agriculture farming approaches.

KEYWORDS: Hydroponics, *Triticum* sp., *Spinacea* sp., *Gladiolus* sp., Cereals, Vegetables, and Flowering crops, Hoagland solution.

INTRODUCTION

The soil-less culture mainly refers to hydroponics and aeroponics. The term hydroponics was derived from Greek words "hydro" means water and "ponos" means labour (Beibel, 1960). It is a method of growing plants in mineral nutrients solution without soil, but in the presence of artificial supporting medium (Bhattarai et al., 2008; Sardare and Admane, 2013). It is a more rational use of water resources, to provide better opportunities for a sustainable food supply in both developed and developing countries (Besthorn, 2013; Podmirseg, 2014). It offers the ability to reuse water and nutrients, ease of environmental variability control, higher production yield and successive prevention of soil-borne diseases and pests (Molitor, 1989; Lommen, 2017). It was estimated that 700 million consumers depend on the vegetables grown in untreated or partially treated wastewater, and the health risks for those involved in the production chains are questionable (Hamilton et al., 2007; Jiménez and Asano, 2008). These available wastewaters may contain nutrients that favor the crop growth, but could possibly exceed the physiological demand to administer toxic effects, and might be subjected to bio-accumulative impacts throughout the food chains. These available wastewaters may contain nutrients that favor the crop growth, but could possibly exceed the physiological demand to administer toxic effects, and might be subjected to bio-accumulative impacts throughout the food chains (Gericke, 1940; Keraita et al., 2008). This system helps to solve the problem of climate change. It also helps in the management of efficient utilization of natural resources and mitigating malnutrition. In India, hydroponics was introduced in the year 1946 by an English scientist, W. J. Shalto Douglas and written a book on hydroponics, entitled "*Hydroponics: The Bengal system*" (Douglas, 1975). Maeva Makendi proposed a hypothesis and stated "if the hydroponic plants and plants grown in soil are given the same germinating and growing conditions, then the hydroponic plants will do well if not even better than the plants grown in soil". The hypothesis was corroborated to the findings on soil-less and soil-based systems (Kazzaz and Kazzaz, 2017; Kumari et al., 2018; Somerville et al., 2018). The experiment was done on different kind of plants for one month and hydroponic plants did germinate and grew faster than soil plants (Cho et al., 2017; Montgomery, 2018). In recent years, NASA has done extensive hydroponic research for its controlled ecological life support system, CELSS (Pandey et al., 2009). As it does not required soil for plant growth, it may be helpful for the astronauts during their time in space to get their food. This helps both home gardeners and commercial vegetables to grow food in places where traditional soil system is not possible or cost-effective. Plants in the hydroponic system can achieve 20–25% higher yields than a soil-based system with productivity 2–5 times higher.

MATERIALS AND METHODS

At first the viable seeds of wheat, spinach, bulbs of sword lily were selected for experiment. The viability of seeds was checked by just soaking them in water and those float in the water were supposed to non-viable seeds and discarded. The next step was to prepare the nutrient media, the Hoagland solution after Hoaglan and Arnon (1938). The seeds/corms were placed in different trays and soaked them in two different solutions i.e. Hoagland solution and tap water. After the germination of seeds, these get transferred in baskets after Jensen and Collins (1985). The growth patterns of plants were noticed periodically for each experimental seeds in respective baskets. The differences in growth as plant length were measured and recorded. The plants were harvested after its full or optimum growth.

RESULTS

In hydroponics system, plants roots were suspended in nutrient-rich water so that they could grow without the use of any chemicals. The whole experiment was taken almost 2 months to complete. The growths of plants were measured for 5 to 20days. The height of plants was measured to indicate the difference in growth.

Wheat (*Triticum* sp.): The seeds of wheat were grown in both Hoagland solution as well as tap water and the growth was observed for 15 days (Fig. 1). The seeds soaked and grown in Hoagland solution showed very good plant length up to 30cm. However, the seeds that were soaked and grown in tap water grown up to the height of 10cm only.

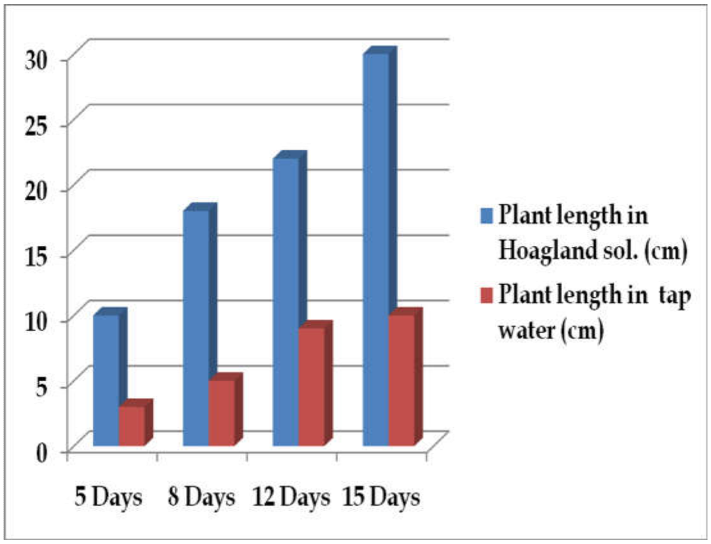

Figure 1: Differential growth of wheat plants when seeds were soaked in Hoagland solution and tap water.

Spinach (*Spinacea* sp.): The seeds of spinach were grown in the Hoagland solution and tap water separated for 8 days and observed carefully (Fig. 2). The seed which were soaked in Hoagland solution showed moderate growth firstly but as the days passed turned yellowing with height of 5cm and died ultimately. The seeds that were soaked in tap water grown up to 2cm only and died.

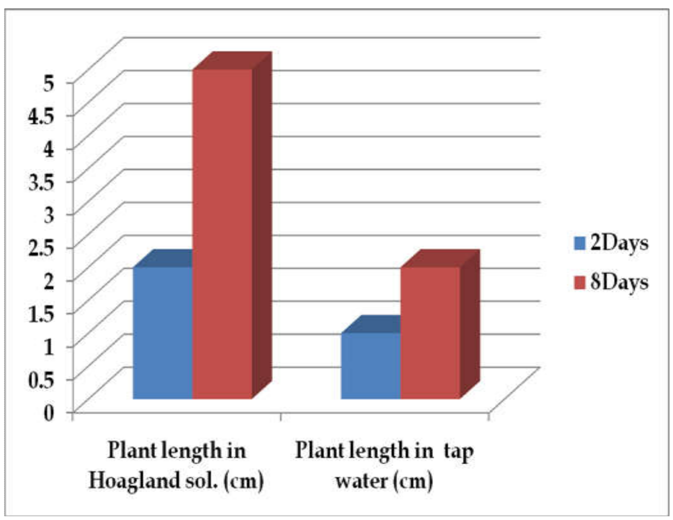

Figure 2: Effect of Hoagland solution and tap water on growth and development of spinach.

Sword lily (*Gladiolus* sp.) The corms of sword lily were planted in both Hoagland solution and tap water separately and observed for 20 days (Fig. 3). The corms that were soaked and planted in Hoagland solution showed a full-fledged growth as compare to tap water as. The corms planted in tap water grown up to 2cm in height and then died.

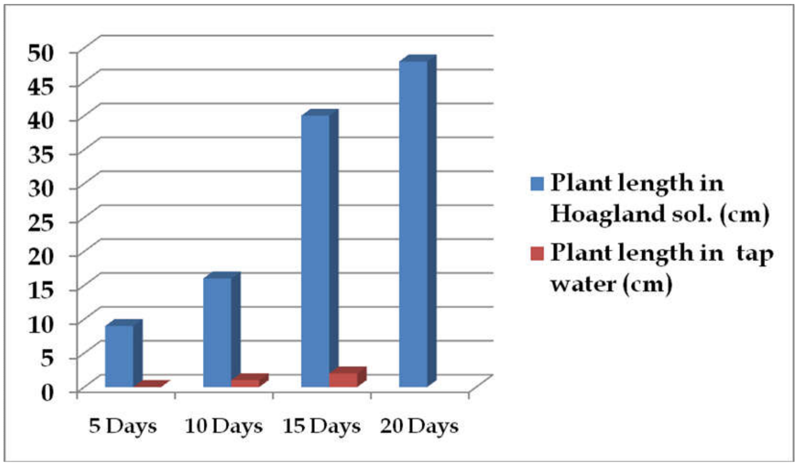

Figure 3: Differential growth of sword lily soaked and planted in Hoagland solution and tap water.

DISCUSSION

The data showed plants that were germinated hydroponically in Hoagland solution did grown faster than the tap water plants. After the germination of seeds and corms of selected plant breeds, the difference in the speed of growth was noticeable in the height of plants. The differences in the size of leaves were little but the length or height showed a significant difference between the plants growing in Hoagland solution and tap water (Ferguson et al., 2014). All plants in the hydroponic system survive, germinated and grew. They only could die in the middle of experiment when there was shortage of nutrients in water system as well as oscillations in temperature. The hypothesis of the experiment was accepted for changing the traditional planting system or farming methods will influence the plant height and growth (Ghamonde et al., 2016). In this case the hydroponic system has a better effect as it made the plant grow faster (Gashgari et al., 2018). According to Sardare and Admane (2013) crops grown in soil-less culture are healthier and also more reliable than crops grown in soil. Although many studies have proven that hydroponics takes the advantages over the regular soil farming, there are still some limitations to using this system (Gashgari et al., 2018). In fact, the hydroponic system requires more skills good knowledge of its principles to maintain the production and because this systemdepends on electricity, power outages can cause damage to the planted crops (Samangooei et al., 2016). In context to the cost, hydroponics required much more money and investment as compared with soil-based traditional farming regardless its savings in the long run (Sardare and Admane, 2013; Kazzaz and Kazzaz, 2017; Kumari et al., 2018).

CONCLUSION

The final results showed that hydroponic planting system has a better effect than tap water system as it made plants heights grow faster. On the other hand, the planting system has no significant effect on the length of leaves. Moreover, seed type and the interaction between seed type and the planting system have no significant effect on plant growth. For future work, the experiment will be done on a larger scale that will be helpful in exploration whether the hydroponic system will meet the demand of today and future market and sustainable demand of agriculture system for livelihood, mankind and economy.

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