



A REVIEW ON EFFECT OF POTASSIUM AND CALCIUM ON DIFFERENT PARAMETERS ON PLANTS UNDER HYDROPONIC CONDITION

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ABSTRACT

Hydroponics is a technique for better plant production in a liquid nutrient solution and without use of soil or artificial media. In this method almost all terrestrial plants, ornamental crops, vegetables, and foliage plants can be grown with their roots immersed directly to the mineral nutrient solution. This system provides better and higher crop yields, minimize the time of production and there is no weeding or cultivation required. The effect of calcium and potassium concentration affect the shoot, root and on the growth of plants. It enhance the structural, physiological as well as morphological parameters of plants. It shows the better quality and high yield of crops. This review is focused on the effect of potassium and calcium on the growth and productivity of plants. This article also evaluates the role of K and Ca under hydroponic system to test the different parameters.

KEYWORDS : *Hydroponic, Potassium, Calcium, Growth and Productivity.*

1. INTRODUCTION

The term 'Hydroponics' was derived from Greek word 'hydro' means water and 'ponos' mean labor. Hydroponics is a modern agriculture technique that uses mineral nutrient solution rather than soil for crop production (Fraz Ahmad Khan *et al.*,2018). Hydroponics was found to be better alternative and can be defined as the cultivation of plants without soil, which is being commercially used in the most of the western countries. This study explores the applications of this cultivation technique and to reveal its future importance. This method can be adapted to almost all the terrestrial plants. Vegetable

food crops like wheat, tomato, spinach, mint, coriander and many more plants are being cultivated in commercial scale. The construction of a hydroponic system requires an initial investment, hard work, and care. Better the yield will be, if approached as it needs. It was recommended that this technique can be adapted as a step to produce the food crops and medicinal plants to meet the global demand, to control the global warming, and there by conserving the Mother Nature for the better future. The increased population, sub-urbanization of the forest (excluding land for commercial food production), improper agricultural practice which altered the soil pH, synthetic fertilizers, pesticides



which drastically reduced the soil flora and fertility which made a quench for the new alternative technique for obtaining the food and medicinal plants of better quality, yield and for growing fresh produce in non-arable areas of the world (Sagar J. Dholwani *et al.*,2018).

developments in the techniques of soil-less culture. In 1929, solution culture was promoted by William Frederick Gerick for agricultural crop production. The term “Hydroponic” was firstly introduced by the William Frederick Gerick in 1937. In 1946, English scientist W.J. Shalto Duglas introduced the Hydroponics in West Bengal India. In 1960-70, commercial hydroponics farms were developed in many countries of the world. Later, during 1980 many automatic and high-tech hydroponics farms were developed around the world (George *et al.*, 2010; Fraz Ahmad Khan *et al.*,2018).

Key factors of soil less culture or hydroponics production (Figure 1) (Aatif Hussain *et al.*,2014).

1.1 Background

In 1627, the most primitive book on soil-less culture was *Sylva Sylvarum* published by Francis Bacon. In 1859-65, German botanists made

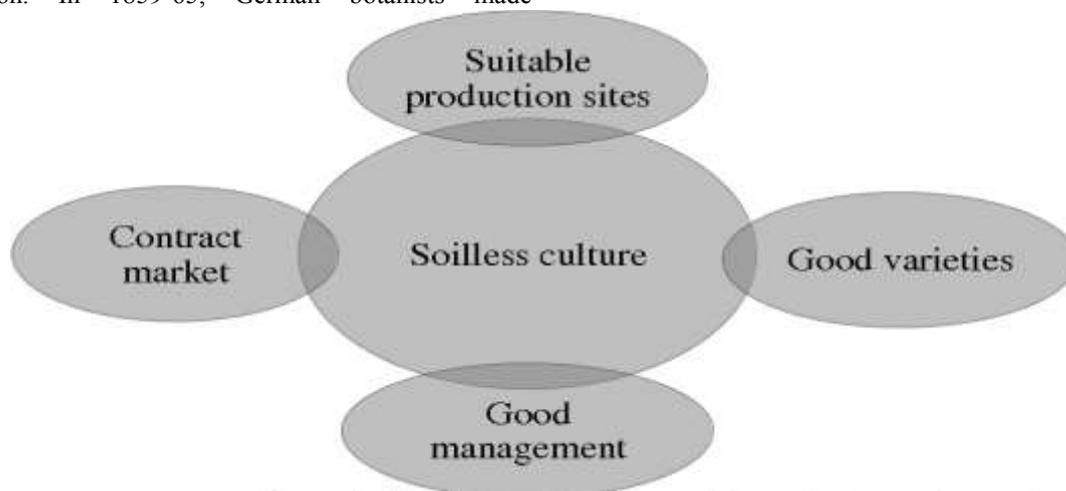


Figure 1. Key factors of soilless culture or hydroponics production

A large number of plants and crops or vegetables can grow by hydroponics system. (Nisha Sharma *et al.*, 2018). Application of pesticides is generally avoided under hydroponics system. (Sagar J. Dholwani *et al.*,2018). Quality of produce, taste and nutritive value of end products is generally higher than the natural soil based cultivation. Various

experimental findings outlines that leafy greens (lettuce, spinach, mint, onion and tomato etc.) can be successfully and easily grown in hydroponic systems. Lettuce and spinach are most promising species to grow in integrated hydroponics and aquaculture systems because of its higher growth and nutrient uptake capacity (Nisha Sharma *et al.*, 2018).

Table1. The Vegetable Production under Soil-Less Culture in India.

Vegetables	Production (g/m ² /day)
Carrot	56.5
Cucumber	226
Garlic	57
Ginger	57
Leek	57
Green Bean	113
Lettuce	226
Onion	56.5
Peapod	113
Potato	56.5
Salad greens	226
Tomato	113
Greens	113

Source: (Singh and Singh, 2012; Aatif Hussain *et al.*,2014)



Calcium has been shown to ameliorate the adverse effects of salinity on plants (Ehret *et al.*, 1990). Calcium is well known to have regulatory roles in metabolism (Cramer *et al.*, 1986; B. Murillo-Amador *et al.*, 2007). Potassium is considered as most ambient macronutrients required for proper

growth, development and sustainable crop yield. Most of the scientists reported that application of 60 kg potassium per ha is the best dose to obtain higher yield of maize. However, it depends on cultivar and soil (Muhammad Adnan *et al.*, 2020).

Table -2. Sources of Nutrient Elements

Source	Element	Characteristics
Potassium nitrate KNO ₃	N, K	Very soluble salt
Potassium phosphate monobasic KH ₂ PO ₄	P, K	Corrects phosphorus deficiency
Magnesium sulfate MgSO ₄	S, Mg	Cheap, highly soluble, pure salt
Iron chelate	Fe Cit	Best sources of iron
Boric acid H ₃ BO ₃	B	Best source of boron
Calcium nitrate Ca(NO ₃) ₂	N, Ca	Very soluble salt

Sources: (Ms. Mamta D. Sardare *et al.*, 2013)

2. EFFECT OF POTASSIUM ON GROWTH AND PRODUCTIVITY

Potassium (K) is one of the most important elements required in large amounts for normal plant growth and development. While involved in many physiological processes, potassium's impact on water relations, photosynthesis, assimilate transport and enzyme activation can have direct consequences on crop productivity. Potassium can be applied as many forms and at different concentration. When potassium uptake is lower than demand, foliar potassium is mobilized to the fruit, to the detriment of plant growth and fruit set and quality (Besford and Maw *et al.*, 1975; Mohsen Kazemi *et al.*, 2014). Intensive research has been done to investigate the effects of K on fruit quality of vegetables grown in hydroponics, showing the significance of K in the nutrition of these crops (Kreij *et al.*, 1999; Lin *et al.*, 2004) found that increasing potassium levels significantly increased the concentration of total sugar, total soluble solids, glutamic acid, aspartic acid, alanine, and volatile acetate of muskmelon (Mohsen Kazemi *et al.*, 2014).

Aside from that the foliar application of KNO₃ has shown beneficial effects on growth, nutrients concentration, NRA and soluble proteins of sunflower and safflower plants, irrespective to their growth under non saline or saline conditions (Nusrat Jabeen *et al.*, 2011). The most limiting macronutrient element is potassium which exhibited the adversely reduction of plant growth patterns in Japanese mint when compared with plants grown under the complete nutrient solution. Omission of potassium may also induce the oxidative stress condition which disrupts cell membrane stability and chlorophyll apparatus. The findings reported herein will be valuable to support optimal cultivation Japanese mint cultured in the hydroponic system (Chananchida Janpen *et al.*,

2019). The effect of potassium (KC) concentration on the nutritional quality and yield of pepper fruits was evaluated. Pepper (*Capsicum annum* L.) plants were grown in a controlled environment greenhouse under hydroponic conditions with different nutrient solutions obtained by modifying the Hoagland solution to achieve different KC concentrations. Potassium nutrition affected fruit yield parameters more than vegetative biomass in pepper plants (M. Ángeles Botella *et al.*, 2016). The effective concentration of K has shown effective improvement of fruit yield and quality seems to be at higher concentration in tomato (Mohsen Kazemi *et al.*, 2014).

Akram M. Studied the response of maize to potassium and reported that increase in potassium levels the maize showed an increase in yield constituents. The maize exhibited maximum yield when potassium was used @ 125 kg ha⁻¹ as compared to the control treatment. They also concluded that potassium @ 125 kg ha⁻¹ produced the economical yield of maize hybrids. (Akram M. *et al.*, 2010; Muhammad Adnan *et al.*, 2020)

3. EFFECT OF CALCIUM ON GROWTH AND PRODUCTIVITY

Calcium (Ca) is an essential macro-element and it is also a very important determinant of plant growth and production. Calcium is a highly mobile element and plays many crucial roles in plant membrane structure and function for forming abundant vegetative mass. It contributes to maintenance of cell membrane stability and wall structure (Wissem HAMDI *et al.*, 2015). Foremother Ca deficiency has been linked to many disorders especially, such as brown center, hollow heart that was thought to be related to tuber Ca level. (Wissem HAMDI *et al.*, 2015; Ozgen *et al.*, 2003) Whereas (Arvin *et al.*,



2005) revealed that increasing plant Ca has been shown to enhance resistance to plant tissue macerating bacterial phytopathogens. It also enhances the structural integrity of cell walls and membranes. Calcium can be applied as calcium chloride, calcium nitrate, calcium sulphate and lime. Studies by (Ahmad *et al.*, 2009) showed that calcium nitrate was highly soluble and more effective in increasing Ca concentration in solution. (Wissem HAMDY *et al.*, 2015).

The effect of CaSO₄ increases the fruit yield and quality of strawberry in saline condition (M. Khayat *et al.*, 2007).

The effects of calcium and potassium level on the plant growth and severity of endive (*Cichorium endivia* L., cv. Green Curled) mainly affected the upper part of endive plants and reduced leaf area. However, when salinity combined with either K- or Ca-enrichment, the negative impact of salinity on plant growth was reversed. K- and Ca- enriched plants did not differ in plant biomass, leaf/root ratio, leaf fresh weight, leaf number, and root length. (Tzortzakakis N.G. *et al.*, 2010).

Presence of calcium increases the life of flowers such as rose, and prevents cut flower rose from opening prematurely. With the use of calcium, such flowers may be an increase in their life cycle by preventing early blossoming of flower buds. Calcium is also beneficial in preventing the early withering of the leaves and would also reduce the atmospheric factors that can also cause withering of the plant leaves. Increasing the concentration of calcium in lily nutrition caused to increase all growth indices particularly plant height, stem and flower diameter, bud numbers, vase life of cut flowers (N. Seyedi *et al.*, 2012).

4. CONCLUSION

As condition of plant growing in soil is becoming difficult because the industry expect to grow intensely in future also. The hydroponic technique is the better option to increase the production of yield. By this technique food security of our country can be secured. Application in influence of K increasing in crop yield and quality at higher concentration show the better results. Added calcium in the nutrient solution may ameliorate and beneficial for crops because it improve growth and productivity of plants. The effective concentration of calcium and potassium as a source has positive response on morphological parameters of the plant.

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