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EFFECTS OF ENVIRONMENT ON GROWING HYDROPONICS MAIZE FODDER USING LOW-COST GREENHOUSE CULTIVATING UNIT FOR LIVESTOCK PRODUCTION.

Management

Adamu, B.* Adamawa State Polytechnic, Yola. *Corresponding Author

Abdullahi, S. Post Primary School Management, Board, Yola Adamawa State.

Saidu, S. G Federal College of Education, Yola Adamawa State.

Yustus Sunday Francis

ABSTRACT

The term 'Hydroponics' was derived from Greek words 'hydro' means water and 'ponics' means labor. Hydroponic is a modern agricultural technique that uses nutrient solution rather than soil solution for fodder production. As population increases the food demand also increased, the existing system of agriculture will not be able to meet the food requirement in the near future due to environmental challenges in the industry. The major environmental factors affecting the hydroponics production system are; Temperature, relative humidity, and light. The objectives of this studies are to examine the hydroponics greenhouse technologies, impact of environmental factors on hydroponics greenhouse cultivation and challenges of growing on hydroponics greenhouse system. This study revealed that hydroponics greenhouse cultivation is a better option for improved fodder production, water utilization, palatability and digestibility.

KEYWORDS

Maize seeds, Maize fodder, Water Nutrients Solution and the Soil Solution

INTRODUCTION

The greatest challenges livestock agricultural production system faced worldwide are maintaining fodder productivity levels with changing climate and depleting soil fertility, to mitigate these adverse effects of climate and soil fertility, there are needs to offer an opportunity to develop a sustainable system to improve fodder production for the livestock industry without the use of soil.

Definition of Hydroponics

The term 'Hydroponics' was derived from Greek words '*hydro*' means water and '*ponics*' means labor as described by Naik *et al.* (2016). Hydroponics is a type of horticulture, subset of hydroculture and a modern agricultural technique using mineral nutrient solutions in an aqueous solvent rather than soil for crops production.

Impact of Environmental Factors on Hydroponics

1. Light Intensity

Several studies were conducted on the effects of low light or intensity on fodder crops production. These studies revealed that low light is one of the problems faced by farmers during hydroponics maize fodder production. The greenhouse structures reduce the amount of daylight received by 30 percent or more and low light intensity reduced the leaf carbon assimilation and accumulation of sugar also decreased due to low light intensity Krishna *et al*. (2017)

2. Temperature

The greenhouse temperatures rise in summer due to solar radiation, chemical reaction and physical properties of plants are affected by different levels of temperature. Generally, the growth rate of maize varieties and biomass productivity increases with increased air temperature from 18 ^{0}C – 25 ^{0}C. Maize fodder Quality are affected by different temperatures pattern, high temperature changes associated with growth factors can cause opening in spite of ventilation, shade and cooling can also change the shapes, color, and texture of maize fodder. Fazaeli *et al.* (2012)

3. Air Humidity

Water status and transpiration (water balance, transpiration cooling, and ion translocation) of hydroponics greenhouse plants are affected by air humidity. Humidity is the most difficult environmental factor to control although quite economical especially during heat. There are different methods used to control the relative humidity, in cool weather, the most effective way to control relative humidity is to open the exhaust window slightly, to allowed heat allied with most of the water vapor to escape. There are many other methods which have been tested but practical solutions have not been provided, there are no effects on crops productivity and development when the vapor pressure deficits range from 0.2 - 1.0 k Pa. Many studies have been conducted on the effects of vapor pressure deficit, it was concluded that when vapor pressure deficit is low in hydroponics greenhouse there will be a reduction in the average weight of tomato plants. When vapor pressure deficit increased from 1.0 - 2.5k Pa in hydroponics greenhouse there will be a reduction in net accumulation of water in maize fodder. Quality of maize fodder is affected by high humidity levels; which caused increase in diseases by spreading pathogens as described by Monika *et al.* (2018)

4. CO_2 Concentration

CO_2 concentration is one of the major environmental factors throughout the history of agronomy or horticulture, the interest in CO_2 enrichment has risen, as many studies carried out on effects of CO_2 enrichment concluded that dry to weight of plants, plants height, number of plants leaves, and lateral branches of plants increases with increased CO_2 enrichment in greenhouse, other environmental factor (temperature and light) also increase with elevated CO_2 concentrations. There are needs for more researches to be conducted on CO_2 enrichment and how it affects the optimal levels of light, temperature and air humidity for a better fodder products and quality Libia *et al.* (2012)

Challenges of Hydroponics Greenhouse Cultivation

(1) Prevalence of Mold

Mold growth is the largest problem in hydroponics fodder production, control mold growth is important to produce healthy and safe fodder. The following steps are to be adopted to produce mold free and healthy fodder for the animals.

1. Use commercial bleach, dilute 1 liter of concentrated bleach with 4-5 liters of clean water to give the concentration needed for sanitizing the seed. adhere to the safety instructions on the original bleach package when handling.
2. Use 1-1.5 liter diluted bleach (solution) to soak the seeds for disinfection, rinse the trays after each batch of fodder production and occasionally spray the fodder with the solution when mold growth has been noticed.
3. 1-2% Hydrogen peroxide can also be used for the same purpose and in the same way bleach is used, as described by Naik *et al*. (2013)

(2) High Initial Cost

Several studies have been conducted on the construction of hydroponics greenhouse structures. Tyson *et al.*, (2004) opined that there should be a climate controlled to monitor hydroponics greenhouse system such as the light intensity, temperature, carbon dioxide concentration, and humidity. Factors such as availability of the system, an initial cost of the system, the efficiency of the system, and transportation cost etc. should be kept in mind during installation of Arduino based climate control system. (Taig, 2012).

The hydroponics installation should not be exposed to direct sunlight, wind and rain. Appropriate lighting for the photosynthetic process to be conducted and assured. Best air humidity for growth of fodder is 40% - 80% (60% optimum) and the ideal temperature is between 19°C - 22°C.

High Maintenance and Running Cost

High maintenance and running cost is one of the major challenges for hydroponics greenhouse crops cultivation, precise temperature ranges to attain the optimal plants growth is one of the major expenses for maintaining hydroponics greenhouse (Wells, 2014; Tavassoli *et al.*, 2010).

Resources to maintain the large concentration of nutrients in the water, energy for pumping the water-mixed nutrients, energy to run exhaust fans, and sensors etc are required. Management, maintenance and running cost are needed for hydroponics greenhouse, management skills are needed for commercial production of any crop in hydroponics greenhouse system as the complexity of the system decides the level of management to be adopted (Higashide *et al.*, 2013).

1. High level of management such as production knowledge of different crops, technical skills, and adequate experience for fodder crops establishment and production in hydroponics greenhouse field are the basic requirements.
2. Growers must be committed to meet the entire requirement in an active means to make successful fodder production (Sigrimis *et al., 2*013).
3. Automatic system for regularly checking and regulating environmental condition inside hydroponics greenhouse should be able to provide enough heat during winter season and chilling or shading during summer season especially in a tropical area where there are extreme seasonal changes (Kuennen *et al.*, 2008).

Irrigation Management

Proper irrigation should be adopted and water should be free from contaminants, as more chances of disease prevalence occurred when water is contaminated (AI-Amri, 2007). Management and special training is required in areas of agronomy (plants cultivar selection and seedling raising area (Othman *et al.*, 2008; Succop and Newman, 2009). Crops selection plays an important role in initial and running cost of hydroponics greenhouse (Alexander and Parker, 2010). Crops production methods such as continuous flow, static flow and nutrient supply to crops with skilled labor are required. (Stone, 2014, Savvas *et al.*, 2007).

1. High irrigation frequency increased DM conservation from 86%-91% of inputs and an improved irrigation techniques were able to offset the temperature effects and reduce DM losses from 7% - 9 % within seven-days period.
2. Clean water is an important factor as muddy water causes hydroponics system to be contaminated and possibly clod the silt distribution pipes, the water should be nearly of drinking quality, the water temperature should be from 15°C (minimum) – 25°C (maximum) and the pH Level should be between 6.2 - 6.4. If necessary mount a filter that will prevent impurities and soils getting into the system, harvesting and storage requires a skilled personnel. (Peckenpaugh, 2004).

Diseases and Pests Management

Hydroponics plants are generally less susceptible to diseases when compared to plants grown in soil, without soil, bacteria and fungi have less opportunity to establish themselves, although certain conditions such as excess humidity, high temperatures and lack of direct sunlight can greatly increase the risk of plants developing diseases that can threaten the entire. Pests and diseases are major problems for hydroponics greenhouse system, advance detection of pests and diseases are needed since plants shared the same nutrients solution, as sharing can result in a quick spread of diseases High degree of sanitation is the only solution for disease free system When water mold is introduced into nutrients solution most of the diseases spread to all parts of the plants through nutrients circulating system.

- To prevent diseases in hydroponics plants, avoid conducive environment for pathogens to thrive, this means avoiding excessively high temperatures and humidity levels and ensure that plants receive direct sunlight or good quality artificial light. Monitor the pH and concentration of nutrients solution. Ensure that nutrients solution contains all the essential macro and micro nutrients that plants required for maximum productivity and growth. Monitor plants frequently for any symptoms of diseases. If disease manifest identifies the causative agents and treat immediately.

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