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## CULTIVATION OF SPINACH IN AUTOMATED MULTITIER HYDROPONIC STRUCTURE

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### ABSTRACT

A field experiment was conducted to comparative study of spinach under controlled atmosphere of hydroponic structure at Instructional Farm Department of Farm Structure, Dr. PDKV, Akola. The experiment was laid out in randomized block design. The structure was 3230 mm long and 1130 mm wide and at a height of 1870 mm. The Web Based Agricultural Statistics Software Package (WASP) was used for analysis of biometric characteristics and quality parameters respectively. The study indicated that the temperature, relative humidity, light intensity and CO<sub>2</sub> inside the green hydroponic structure was favourable for the growth of spinach in the rainy season. Green hydroponic structure showed best results followed by white net and open field hydroponic structure however temperature of white structure greater the 1-3°C as compared to green colour hydroponic structure. Temperature inside the green net, white net hydroponic structure was found 5-6°C less than the outside temperature. The relative humidity inside the green net hydroponic structure was observed in between 30-82% in month of August and September. The relative humidity inside the white net and open field hydroponic structure was observed in between 30-41%. The Relative humidity inside green net hydroponic structure was found 40-42% more as to white net and open field hydroponic structure. But as we compare green and white net hydroponic structure relative humidity inside the green net hydroponic structure was found 1-2% more than white hydroponic structure. The light intensity in open field hydroponic structure was observed in between 50-60% more as compare to green net hydroponic structure. Light intensity inside the green net hydroponic structure was found 5-15% less than white net hydroponic structure. Biometric characteristics of spinach like plant height, number of leaves and stem diameter, internode distance was found maximum in green net hydroponic structure than white net and open field hydroponic structure. The yield was found maximum inside the green hydroponic structure. Quality of spinach on the basis of iron content, chlorophyll content, and yield were found maximum in green shade net followed by white net and open field hydroponic structure. Also, during rainy season, when temperature was high under controlled atmosphere, better quality spinach was obtained than winter season.

**Key words:** biometric characteristics, Hydroponic structure, growing media, NFT Hydroponic

### Introduction

Hydroponics is a technology for growing plants in nutrient solution (water containing fertilizers) with or without the use of an artificial medium (soil, gravel, sand, peat, vermiculite or sawdust) to provide mechanical support. nutrient solution contains all the essential elements needed by the plant for its normal growth and development. Since many hydroponic methods employ some type of medium that contains organic material like

peat or sawdust, it is often termed “soilless culture”, while water culture alone would be true hydroponics.

The Nutrient Film Technique systems have a constant flow of nutrient solution so no timer required for the submersible pump. The nutrient solution is pumped into the growing tray (usually a tube) and flows over the roots of the plants, and then drains back into the reservoir. There is usually no growing medium used other than air, which saves the expense of replacing the growing medium

after every crop. N.F.T. systems are very susceptible to power outages and pump failures. The roots dry out very rapidly when the flow of nutrient solution is interrupted.

Therefore, studies over the last few decades have mainly focused on the development and rehabilitation of new or readily available systems especially aiming to provide more water and nutrient saving, increased yield and decreased waste of nutrients.

### Materials and Methods

A field experiment on “Multitier hydroponic structure with Nutrient Film Technique” was conducted during July 2022 to February 2023 at Instructional Farm, Department of Farm Structures, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. This chapter gives the details of parameters considered for the experimental design and recording of data for the experimental study, procedure and instrumentation considered for conducting experiments and the methodology adopted for data analysis.

#### Nutrient Film Technique (NFT) system process

Nutrient solution was pumped up from the tank to 2 cm diameter PVC pipe delivered to the top of the PVC pipe, the solution discharge in 75 mm PVC pipe was at the rate of 2 l/min. One side PVC pipe water slowly runs down the other end of PVC pipes.

The pipe was positioned at an angle to water flow at approximately 20-30 mm of depth inside PVC pipe. The plants start to consume the nutrient rich water from bottom of PVC pipe, they begin to develop root systems inside the PVC pipes.

Water at the bottom of each pipe that the roots receive large amounts of oxygen at the root zone with water and nutrient. This system supplied constant exchange of the water, nutrient and air to the plant.

### Results and Discussion

During the experiment, the temperature and Relative humidity were recorded at 8, 11, 14 and 17 hours from



Fig. 1: Green net Hydroponic Structure.

Table 1: Average temperature and Relative Humidity in month of August in GNS, WNS and OF.

Time (Hrs)	Temperature °C and RH. %					
	GNS Temp °C	GNS RH %	WNS Temp °C	WNS RH %	OF Temp °C	OF RH %
8	23.32	91.35	25.00	88.35	25.18	80.32
11	25.68	82.92	27.27	80.39	27.66	78.25
14	25.87	85.39	27.47	80.42	27.88	78.50
17	24.38	88.17	25.87	85.21	26.18	80

Table 2: Average temperature Relative Humidity in month of September in GNS, WNS, OF.

Time (Hrs)	Temperature °C					
	GNS Temp °C	GNS RH %	WNS Temp °C	WNS RH %	OF Temp °C	OF RH %
8	24.28	90.5	24.8	87.12	26.11	64.34
11	26.45	81.35	27.45	77.06	28.53	56.34
14	26.89	81.92	27.88	77.25	28.62	52.34
17	25.51	85.31	26.25	82.45	27.43	57.64

4<sup>th</sup> August 2022 to 16<sup>th</sup> September 2022 after the sowing of seeds in green shade net, white shade net and open field hydroponic structure. Table 1 and 2 shows average temperature in green shade net. White shade net and open field structure in month of August and September 2022.

Due to the controlled atmosphere system temperature inside the green net and white shade nethydroponic structure has great influence on crop growth. Temperature inside the green shade net, white shade net and hydroponic structure was found 2-4°C less than the outside temperature. This difference was found due to the installation of foggers and exhaust fans, which helps in controlling the temperature. But as compared to green shade net hydroponic structure has better result of crop than white shade net hydroponic structure. Result obtained during the research work tabulated in the Table 1 and 2 as well as shown in graph. Similar results have been reported for temperature (Rekha Meena *et al.*,

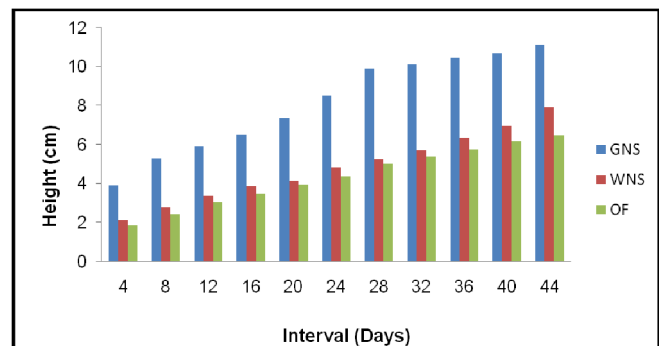


Fig. 2: Average plant height of spinach at four days interval.

**Table 3:** Average light intensity in the month of August in GNS, WNS and OF.

Time (Hrs)	Light intensity (Lux × 10 <sup>3</sup> )					
	GNS		WNS		OF	
	Aug.	Sept.	Aug.	Sept.	Aug.	Sept.
8	254.32	260.14	397.32	302.62	408.07	417
11	322.96	313.71	413.92	367.82	418.85	446.64
14	360.03	340.64	428.17	391.24	433.14	464.57
17	277.78	262.07	439.78	369.65	451.71	470.21

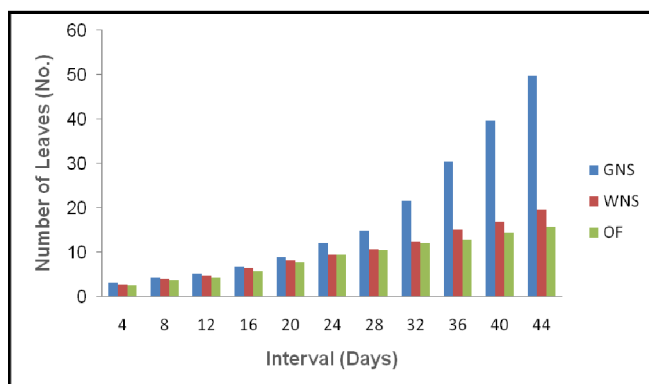
2012) and (Rekha Meena *et al.*, 2014).

The relative humidity inside the green, white shade net and open field hydroponic structures has great influence on crop growth. But as we compare green and white shade net hydroponic structure relative humidity inside the green shade net hydroponic structure was found 1-2% more than white hydroponic structure. This difference was found due to the controlled atmosphere management inside the hydroponic structure. Result obtained during the research work shown in Fig. 3 and Fig. 4. Similar result has been reported for relative humidity (Rekha Meena *et al.*, 2012) and (Rekha Meena *et al.*, 2014)

Table 3 shows average light intensity in green shade net, white shade net and open field hydroponic structure in month of August 2022 and September 2022. The light intensity inside the green shade net, white shade net and open field hydroponic structures has great influence on crop growth. Similar result was reported for light intensity (Rekha Meena *et al.*, 2012) and (Rekha Meena *et al.*, 2014).

Carbon dioxide (CO<sub>2</sub>) exist in atmosphere slightly above 0.02 per cent or 282 ppm. During the day, photosynthesis occurs under natural light, the plants in a greenhouse draw down level of CO<sub>2</sub> below 500 ppm.

Under these circumstances infiltration or ventilation increases CO<sub>2</sub> levels, if the level of CO<sub>2</sub> is less than ambient levels then CO<sub>2</sub> may retard the plant growth.



**Fig. 3:** Average no. of leaves of spinach at four days interval.

**Table 4:** CO<sub>2</sub> concentration in GHS, WHS and OF at five days interval in August to September.

Days/interval	CO <sub>2</sub> concentration (ppm)		
	GNS	WNS	OF
5	302.12	332.2	282.11
10	323.74	346.41	297.42
15	412.29	402.1	299.34
20	466.42	452.25	322.97
25	491.58	458.63	350.43
30	497.89	482.87	366.84
35	512.69	492.86	375.43
40	523.23	501.1	284.32

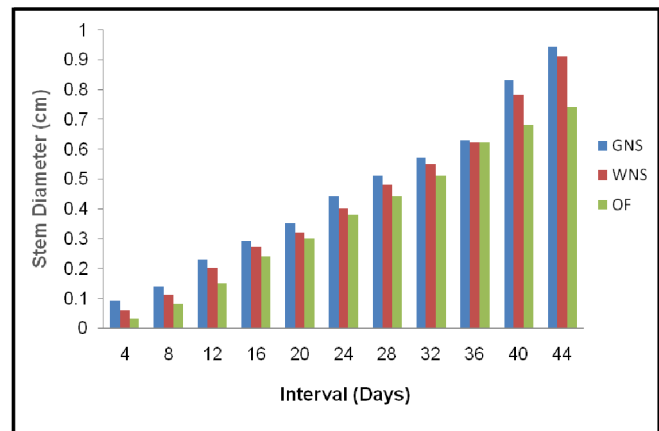
The carbon dioxide (CO<sub>2</sub>) inside the green shade net hydroponic structure has been recorded for 5, 10, 15, 20, 25, 30, 35, 40 45 days of interval.

**Biometric observations**

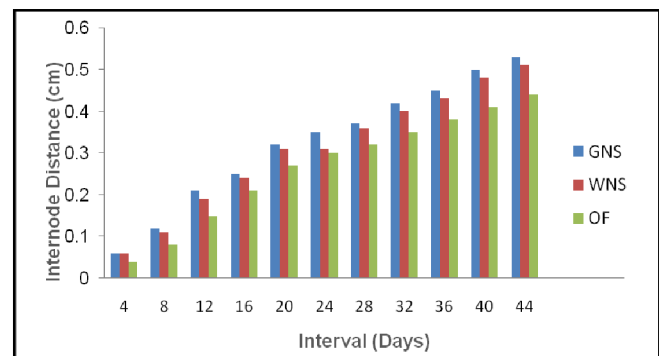
**Height of plant**

The plant height of spinach was influenced significantly in green shade net, white shade net and open field hydroponic structures at all crop growth stages.

From Fig. 2 it was observed that during initial growth stage, at 8 and 12 days height of spinach plant found at par then highest value for green hydroponic structure. After green hydroponic structure shows better result in remaining two structure. Height of spinach was found



**Fig. 4:** Average stem diameters of spinach at four days interval.



**Fig. 5:** Average internode distance of spinach at four days interval.

maximum inside green hydroponic structure at the time of harvest and it was found about 11.1 cm

### Number of Leaves

It was observed that during initial growth stage, at 4<sup>th</sup> days of interval no. of leaves of plant was found at par then highest value for green hydroponic structure in month of August and September. After green hydroponic shows better result in remaining two structures. No. of leaves of spinach was found maximum inside the green hydroponic structure at harvest it was found about 50 Number of leaves (Fig. 3).

### Stem Diameter

The stem diameter of spinach was influenced significantly in hydroponic structures at all crop growth stages. Then highest value for green hydroponic structure, stem diameter of spinach was found maximum inside the green hydroponic structure at harvest it was found about 9.4 mm (Fig. 4).

### Conclusions

1. The biometric characteristics *i.e.*, height of plant, number of leaves, stem diameter and internode distance inside the green net was found two times more than the white net hydroponic structure.
2. Quality parameters *i.e.*, moisture content, iron content, chlorophyll content and leaf area of spinach was found maximum inside the green colour hydroponic structure. The Moisture content was found (86.37%), iron content (272.569 ppm), chlorophyll content 40.531 (mg/gm) and leaf area (46.17cm<sup>2</sup>) found in green hydroponic structure.
3. Yield of spinach in the green net hydroponic structure

was found greater (1.5162 kg/m<sup>2</sup>) followed by white colour hydroponic structure, (1.3270 kg/m<sup>2</sup>), followed by Open field hydroponic structure (0.9953 kg/m<sup>2</sup>). The yield in green hydroponic structure were found to be higher than white net and open field hydroponic structure.

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