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Effect of Different Colour of Shadenet and Growing Media on the Biometric Characteristics and Yield of Spinach Cultivated by Hydroponics

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ABSTRACT

The experiment was conducted during summer season of 2016- 2017 at the field of Department Farm Structures, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The dimensions of portable hydroponic structure were 1375 mm x 925 mm (H X L) and was made up of mild steel hollow pipes of size 25.4 mm which were bended and welded together to form a Quonset-type structure. Cultivation of spinach by using two different hydroponic methods was carried out under controlled atmosphere and in the open field. Solid media culture and liquid hydroponics were used and in solid media three different types of media such as cocopeat, soil rite and 50% cocopeat and 50% soil rite. The biometric characteristics such as height of plant, number of leaves and stem diameter (the green colour hydroponic and white colour hydroponic) was found two to three times more as compare to the open field condition. The yield of spinach was found more in the green colour hydroponic structure in between 150-210 q/ha. The yield was found 120-200 q/ha inside the white colour hydroponic structure as compare to the open field and it was 50-80 q/ha.

Key words: *Hydroponics, Cocopeat, Soil rite, Biometric characteristics, Steam diameter*

INTRODUCTION

Hydroponic culture is possibly the most intensive method of crop production in today's agricultural industry in combination with greenhouses. yet, for most of its employees, hydroponic culture requires only basic agricultural skills. Since regulating the aerial and root environment is a major concern in such agricultural systems, production takes place inside enclosed design to control air and root temperatures, light, water, plant nutrition and adverse climate[2]. Soil is usually the most available growing medium for plants. It provides anchorage, nutrients, air, water, etc. for successful plant growth.

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Presence of disease causing organisms and nematodes, unsuitable soil reaction, unfavorable soil compaction, poor drainage, degradation due to erosion etc. are some of them. In addition, conventional crop cultivation in soil (Open Field Agriculture) is somewhat difficult as it involves large space, lot of labour and large volume of water. Moreover, some places like metropolitan areas, soil is not available for crop growing at all, or in some areas, we find scarcity of fertile cultivable arable lands due to their unfavorable geographical or topographical conditions. Of late, another serious problem experienced since is the difficulty to hire labour for conventional open field agriculture. Under such circumstances, soil-less culture can be introduced successfully.

Kratky[6]. studied the Suspended Net-Pot, Non-Circulating Hydroponic Method for Commercial Production of Leafy, Romaine, and Semi-Head Lettuce. Nxawe[8]. studied the effect of regulated irrigation water temperature on hydroponics production of Spinach (*Spinacia oleracea L.*). The effects of different temperature regimes of irrigation water on the growth rate of *Spinacia oleracea L*. were determined in the greenhouse for 8 weeks.

The very limited information is available regarding the cultivation of vegetables and the biometric characteristics of spinach by different hydroponic methods. Therefore the study is taken with the similar objective as to study the environmental parameters, biometric characteristics and yield of spinach in different colour hydroponic structure.

MATERIAL AND METHODS

The experiment was conducted during summer season of 2016- 2017 at the field of Department Farm Structures, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The total area of portable hydroponic structure was 2228.325 X 10^3 mm^2 used for the cultivation of spinach. Two hydroponic methods were selected for the Spinach cultivation one was solid media culture in this method locally available growing media were used for the cultivation cocopeat and soil rite. Types of media culture was used such as solid media and liquid media. The different combinations are as follows,

1) Types of structures- i) Green hydroponic structure
ii) White hydroponic structure
iii) Open field

2) Cultivation Media- i) Cocopeat
ii) Soil rite
iii) 50% cocopeat 50% soil rite
iv) Liquid media

Spinach seeds was sowed in the solid media and in the hydroponic cups for the liquid media. Nutrient dose was applied at 5 days equal interval as 1 g/ lit of 19:19:19 as major nutrient and suprimo 5 ml. in lit. of water as micro nutrient for solid media and also for liquid media cultivation.

The environmental parameters like temperature, relative humidity, light intensity and CO_2 were measured from 6thmarch, 2017 to 23rdApril, 2017 under controlled condition.

Biometric Characteristics of Plant

Various plant parameters were measured in Green and white portable hydroponic structure and open-field during the experimental study. Five plants were selected from each growing medium for the measurement of plant height, stem diameter of plant, number of leaves per plant. The observations such as plant height, stem diameter, number of leaves per plant were recorded at an interval of 15 days after germination up to 45 days duration. All the observations were analysed statistically. Similar study was done by Rekha Meena *et al.*[10].

Plant height

The plant height was measured in centimetre (cm). Five plants were selected to measure the plant height. The average plant height value of five plants was worked out.

Stem diameter

The stem diameter of plants in both conditions were measured with digital vernier caliper. Five plants were selected to measure the stem diameter. The average stem diameter value of five plants was worked out.

Number of Leaves

Five plants were selected for the measurement of number of leaves. Number of leaves of each plant were measured manually.

RESULTS AND DISSCUSSION

Temperature inside the green and white colour hydroponic structure was found 5-10 ^{0}C less than the outside temperature which is favourable for the growth of spinach. The inside temperature of white structure greater the 1-2 ^{0}C as compared to green colour hydroponic structure. The relative humidity inside the green and white colour hydroponic structure was observed in between 31-40% as on the open field relative humidity was found between 10-15%. Relative humidity inside green and white colour hydroponic structure was found 20-35% more as compare to open field. When comparison between green and white colour hydroponic structure relative humidity inside the green colour portable hydroponic structure was found 2-5 % more than white colour hydroponic structure. Light intensity inside green and white colour hydroponic structure was found 5-10% less than the open field. When comparison between green and white colour hydroponic structure light intensity inside the white colour hydroponic structure was found 1-3% more than green colour hydroponic structure. The C02 concentration in the green hydroponic structure was recorded higher 1-2 time more as compared to the white hydroponic structure and open field at all crop growth stages.

Biometric observations

The biometric observations on various growth characters viz., plant height, no. of leaves and stem diameter were recorded periodically from the date of transplanting at fifteen days interval of five plants in each growing media in the green hydroponic structure, white hydroponic structure and in open field.

Statistical analysis of biometric observations were carried out in Completely Randomized Design, in which two main factors were include these are Factor A- Structures and Factor B- Growing Media, in the factor A there are three levels these are A1- Green Hydroponic structure, A2- White Hydroponic Structure and A3- Open field. In the factor B there are four levels these are B1- Cocopeat, B2- Soil Rite, B3- Cocopeat + Soil Rite and B4- Liquid.

Height of the plant-

The plant height of spinach was influenced significantly due to different hydroponic structures and growing media at all crop growth stages.

Table 2: Mean Plant height as influenced by different hydroponic structure and growing media at five days interval

	15 days interval				
A1	2.000	1.800	1.800	2.500	2.025
A2	1.380	1.140	1.220	1.420	1.290
A3	1.380	1.140	1.220	1.420	1.290
Mean B	1.713	1.507	1.640	1.967	
	Factor(A)	**Factor(B)**	**Factor(A XB)**		
F-test	sig	Sig	sig		
SE(m)	0.038	0.044	0.075		
C.D.	0.108	0.124	0.215		
	30 days interval				
A1	3.600	3.300	3.320	5.060	3.820
A2	3.180	3.160	3.340	4.060	3.435
A3	2.660	2.620	2.920	2.700	2.725
Mean B	3.147	3.027	3.193	3.940	
	Factor(A)	**Factor(B)**	**Factor(A XB)**		
F-test	sig	Sig	sig		
SE(m)	0.053	0.061	0.105		
C.D.	0.150	0.173	0.300		
	45 days interval				
A1	5.540	4.880	5.260	6.960	5.660
A2	5.000	4.820	4.840	5.900	5.140
A3	3.820	3.620	3.880	3.900	3.805
Mean B	4.787	4.440	4.660	5.587	
	Factor(A)	**Factor(B)**	**Factor(A XB)**		
F-test	sig	Sig	sig		
SE(m)	0.062	0.071	0.124		
C.D.	0.176	0.204	0.353		

From Table 2, it was observed that during initial growth stage, at 15 day interval height of plant was found at par and highest value for green hydroponic structure with liquid media and green hydroponic structure with cocopeat media. Were as it was found significantly lower in open field in all four growing media. At 30 and 45 days interval height of plant was found at par and highest value for the green hyroponic structure with liquid media and white hydroponic structure with liquid media. As compaired to other green hydroponic structure with liquid media shows better result in remaing three growing media. Were as it was found significantly lower in open field in all four growing media. Height of spinach was found maximum (6.96 cm) inside the green hydroponic structure with liquid media at the time of harvest.

Number of Leaves (Nos.)

The number of leaves of spinach was influenced significantly due to different hydroponic structures and growing media at all crop growth stages.

Table 3: Mean number of leaves as influenced by different hydroponic structure and growing media at five days interval

	15 days interval				
A1	4.400	4.000	4.800	5.600	4.700
A2	4.400	3.600	4.800	5.200	4.500
A3	2.800	2.400	3.600	4.800	3.400
Mean B	3.867	3.333	4.400	5.200	
	Factor(A)	**Factor(B)**	**Factor(A XB)**		
F-test	sig	Sig	NS		
SE(m)	0.280	0.323	0.560		
C.D.	0.798	0.922	N/A		
	30 days interval				
A1	9.200	9.200	9.200	10.800	9.600
A2	7.600	7.200	8.400	10.000	8.300
A3	5.600	4.800	5.600	5.200	5.300
Mean B	7.467	7.067	7.733	8.667	
	Factor(A)	**Factor(B)**	**Factor(A XB)**		
F-test	sig	Sig	NS		
SE(m)	0.314	0.362	0.627		
C.D.	0.894	1.033	N/A		
	45 days interval				
A1	11.200	10.000	10.400	12.800	11.100
A2	9.200	9.200	10.000	10.800	9.800
A3	6.800	5.600	6.800	7.600	6.700
Mean B	9.067	8.267	9.067	10.400	
	Factor(A)	**Factor(B)**	**Factor(A XB)**		
F-test	sig	Sig	NS		
SE(m)	0.265	0.306	0.529		
C.D.	0.755	0.871	N/A		

From Table 3, it was observed that during initial growth stage, at 15 day interval no. of leaves of plant was found at par and highest value for green hydroponic structure with

liquid media and green hydroponic structure with cocopeat and soil rite media. Were as it was found significantly lower in open field in all four growing media. At 30 and 45 days interval number of leaves of plant was found at par and highest value for the green hyroponic structure with liquid media and white hydroponic structure with liquid media. The liquid media green hydroponic structure shows better result in remaing three growing media. Were as it was found significantly lower in open field in all four growing media. There was no significant effect on interaction on number of leaves. The number of leaves (12.800) of spinach was found maximum inside the green hydroponic structure with liquid media.

Stem Diameter

The stem diameter of spinach was influenced significantly due to different hydroponic structures and growing media at all crop growth stages.

Table 4: Mean stem diameter as influenced by different hydroponic structure and growing media at five days interval

	15 days interval				
A1	0.944	0.614	0.880	1.268	0.927
A2	0.802	0.544	0.652	1.122	0.780
A3	0.350	0.300	0.340	0.488	0.370
Mean B	0.699	0.486	0.624	0.959	
	Factor(A)	**Factor(B)**	**Factor(A XB)**		
F-test	sig	Sig	sig		
SE(m)	0.018	0.021	0.036		
C.D.	0.051	0.059	0.102		
	30 days interval				
	B1	**B2**	**B3**	**B4**	**Mean A**
A1	1.996	1.510	1.764	2.694	1.991
A2	1.900	1.488	1.604	2.382	1.844
A3	1.188	1.140	1.090	1.202	1.155
Mean B	1.695	1.379	1.486	2.093	
	Factor(A)	Factor(B)	Factor(A XB)		
F-test	sig	Sig	sig		
SE(m)	0.024	0.028	0.049		
C.D.	0.070	0.080	0.139		
	45 days interval				
A1	2.848	2.478	2.614	4.102	3.011
A2	2.778	2.362	2.386	3.646	2.793
A3	1.384	1.382	1.280	1.440	1.372
Mean B	2.337	2.074	2.093	3.063	
	Factor(A)	**Factor(B)**	**Factor(A XB)**		
F-test	sig	Sig	sig		
SE(m)	0.036	0.041	0.071		
C.D.	0.102	0.117	0.203		

From Table 4, it was observed that during all growth stages, at 15, 30, 45 days interval stem diameter of plant was found at par and highest value for green hydroponic structure and liquid media and white hydroponic structure and liquid media. Were as it was found significantly lower in open field in all four growing media. The liquid media green hydroponic structure shows better result in remaing three growing media. Were as it was found significantly lower in open field in all four growing media. The stem diameter (4.102 mm) of spinach was found maximum inside the green hydroponic structure with liquid media.

Yield

The Design expert trail version 9.0.2.0 software was used to analyze the result using response surface methodology (RSM) which is a collection of mathematical and statistical technique that are useful for modeling and analysis of problems in which a response of interest is influenced by several variables[7]. Table 5 shows the effect of structures and growing media on the yield of spinach.

Analysis of variance for yield

Table 5: ANOVA showing the effect of structures and growing media on yield of spinach

Source	Sum of Squares	Df	Mean Square	F Value	p-value Prob >F	
Model	78664.82	5	15732.96	36.62	< 0.0001	significant
A-Structure	59046.61	2	29523.31	68.71	< 0.0001	
B-Growing Media	19618.20	3	6539.40	15.22	< 0.0001	
Residual	12889.87	30	429.66			
Lack of Fit	4490.44	6	748.41	2.14	0.0859	not significant
Pure Error	8399.43	24	349.98			
Cor Total	91554.68	35				
Std. Dev.	20.73					
Mean	127.72					
C.V. %	16.23					
R^2	0.8592					
Adj R^2	0.8357					
Pred R^2	0.7973					

The equation describing the effects of Structure and growing media on yield in terms of coded values of variable is given as:

Yield = +127.72+29.72* $A_{[1]}$ +27.54* $A_{[2]}$ -6.60* $B_{[1]}$ -27.28* $B_{[2]}$ -3.29* $B_{[3]}$

(R^2 – 0.8592)……..1

Figure 6 shows that effect of growing media and structure on the yield of spinach. Green hydroponics structure with the liquid media shows the better result than the open field. Also for remaining three growing media with green hydroponic structure shows the higher yield.

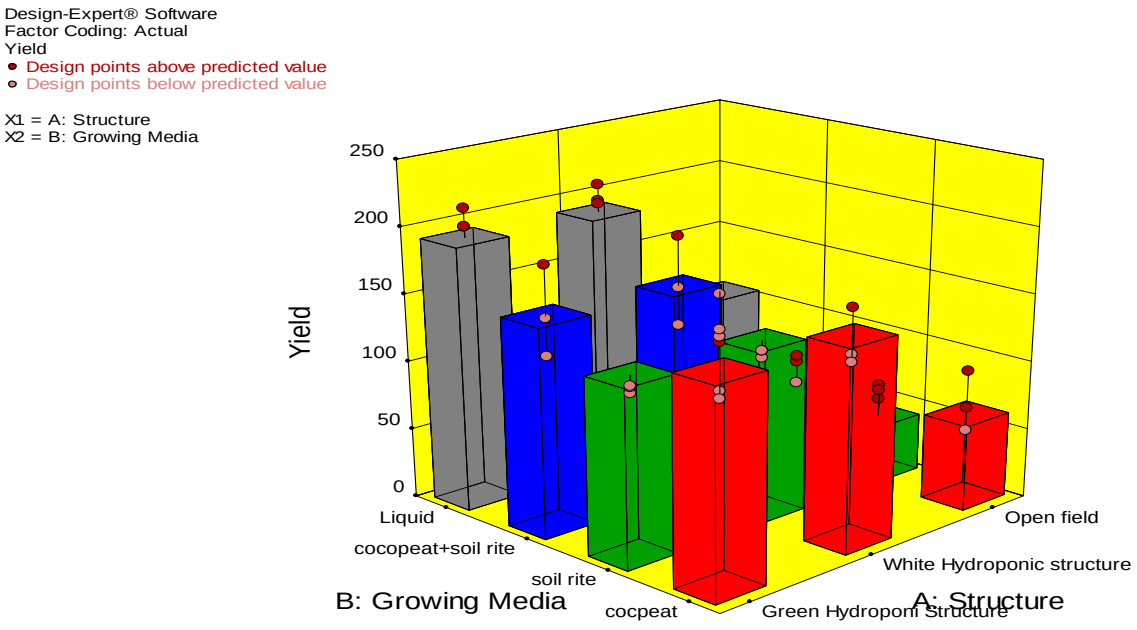

Fig. 6: Effect of hydroponic structure and growing media on yield

CONCLUSION

Temperature inside the green and white colour hydroponic structure was found 5-10 ^{0}C less than the outside temperature which is favorable for the growth of spinach. The inside temperature of white structure greater the 1-2 ^{0}C as compared to green colour hydroponic structure. The relative humidity inside the green and white colour hydroponic structure was observed in between 31-40% as on the open field relative humidity was found between 10-15%. Light intensity inside green and white colour hydroponic structure was found 5-10% less than the open field. Biometric characteristics i.e. height of plant, number of leaves, stem diameter, inside the green colour hydroponic and white colour hydroponic was found two to three times more than the open field condition. Yield of spinach was found greater in the green colour hydroponic structure in between 150-210 q/ha. Yield inside the white colour hydroponic structure was found between 120-200 q/ha and in the open field it was found between 50-80 q/ha. Yield on the open field was found 2 times less as compare to the green and white hydroponic structure.

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