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Influence of Different Nutrient Concentration on Strawberry under Hydroponic Cultivation System

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A B S T R A C T

The present investigation entitled 'Influence of different nutrient concentration on strawberry under hydroponic cultivation system'was carried out during 2016 to 2017 at agriculture field of School of Agriculture, Lovely Professional University, Punjab. In this research takes the seven treatments in hydroponic system. The experiment is carried out in wooden box block design structureand to evaluate the higher success in terms of plant height, plant stem girth, number of leaves/plant, leaf area, number of branches/plant, number of flowers/plant, number of fruits/plant, yield/plant and harvesting index. The maximum plant height and number of fruits/plant was noted in T_5 at 90 days. And maximum stem girth, leaf area, number of branches/plant noted inT_7 at 75 days while the maximum number of leaves and yield/plant recorded in T_6 at 90 days.

Introduction

Strawberry (*Fragaria x ananassa*) is the popular soft fruit and mainly grows in sub-tropical. Now a day, the production of strawberry is goes down due to many climatic condition like more temperature and less agronomical practices. It needs more care and management as compare to the other crops. And it cultivated mainly in controlled environment, but that control environment having more cost of cultivation. The farmer also having less land for taking crops. So that in modern world new technique of cultivation is developed which is called hydroponics system it help in to increase the yield and good growth of crops. Hydroponic system is the stared in 1627 but discussed earlier in a book of Syva Sylvarum by Francis Bacon. And John Woodward published an experiment with spearmint. And found that the spearmint is grown better on the water as compare to other soil culture (Douglas *et al.*, 1975). Hydroponic is the cultivation of crop without soil environment. In hydroponic mainly using different type of media or nutrient solution for growing crops. And keep the root of the plant in the solution of nutrient. Mainly vermiculite, cocopeat, bark of plant, perlite, and rock wool are used. And hydroponic is many types like wick system, flood and drain system, drip system and N.F.T system (Nutrients Film Techniques). On the other hand, every kind of nutrients is

used in this system. One advantage is the soil born disease of strawberry is totally end. But this is for that type of farmer they are not having much land for cultivation. So this hydroponic system is best for marginal farmer. In India new reached is worked on that system because it produces good quality of crop and production. It reduces the disease of crops those which are disseminated by the soil and also reduce the rotting of strawberry fruits. But this system shows the good result in quality of strawberry and other growth parameter. Now due to increase of demand has caused emphasis on modern strawberry producing systems such as without soil cultivation or hydroponic system to replace the old and traditional systems of cultivation. Hydroponic required more care as compare to field crops. Like checking of pH, EC and concentration of nutrients during crop duration. This system is also good for terrace farming in home for kitchen farming. And for the small farmer, it is best method of taking more income.

Materials and Methods

Location of research

It is carried out at Experimental Farm of School of Agriculture, Lovely Professional University, Phagwara, Punjab. The experiment shall be laid out on pot with three replications. The package of practices for raising the crop shall be followed as per latest Punjab Agriculture University guidelines and check the Nitrogen, Phosphorus, Potassium and organic carbon of soil. And hydroponic nutrients solution used in NFT structure.

Observation details

For the determination of the plants growth& fruit quantity selected various parameters viz; plant height (cm), plant girth (mm), number of leaves/plant,leaf area (cm^2), number of branches/plant, number of flowers/plant, number of fruits/plant, yield/plant and harvesting index.

Statistical analysis

The data collected during the course of investigation were subjected to statistical analysis by adopting appropriate method of analysis of variance as described by Fisher. The critical difference for the treatment comparison was worked out, wherever the SPSS 16 is used to analysis the data.

Results and Discussion

The plant height, stem girth, number of leaves/plant, leaf area and number of branches/plant noted at 15, 30, 45, 60, 75 and 90 days after transplanting (Tables 1–5). And number of flowers/plant, number of fruits/plant was observed at 45, 60, 75 and 90 days after transplanting while Yield/Plant, Harvesting Index recorded at 90 days after transplanting (Tables 6–9).

At 15 days the plant height was noted maximum (5.03cm) and minimum (4.03cm). And at 60 days the plant height increase 18.94% as compared to the 45 days; however the variation is from 5.86-7.23cm and the T_5 (25%RDF +75% Vermicompost) shows the best impact on the plant height. Some researcher (Patil *et al.,* 2013) showed that the different type of mulching colour played a great role in the plant height. Black polythene mulching shows the 24.03cm and white polythene shows the 22.4cm height of plants. The GA_3@ 75 ppm shows the best growth in plant height (46.10cm) in strawberry plant (Rakeshkumar *et al.,* 2013). The plant height is depends on the dose of nitrogen also like 100 kg N/ha + 80 kg K/ha treatment shows the best plant height 14.30-18.16cm (Gowhar A. Dar *et al.,* 2013). At 15 days, 46.15% increase stem girth in between the treatment;

at 30 days, 52.94% increase; at 45 days, 42.85% increase in stem girth; at 60 days 31.81% increase in stem girth; At 75 days 33.33% increase in the stem girth respectively. At 30days stem girth observation show 23.52% increase as compared to stem girth of 15days; however the variation in treatment are from 0.08-0.17 mm and treatment T_6 (30% sewage sludge +70% cocopeat) shows best impact on stem girth. The changing in the growth of strawberry depends on the organic manure like poultry manure shows the best impact on the growth parameter due to its height nutrient availability (Kirad *et al.*, 2009).

At 45days, stem girth observation shows 23.80% increase in stem girth as compared to stem girth of 30days; however the variation in treatment are from 0.12-0.21mm and treatment T_5 (20% sewage sludge +80% cocopeat) shows the best impact on stem girth. Different types of substrate influence in the growth of strawberry plant like cocpeat + perlite show the best impact on the plant height, stem girth, fruits weight etc. (Razieh Ebrahimi *et al.*, 2012). At 60days the result shows that 13.63% increase in stem girth as compared to the 45 days; however the variation in treatment from 0.15-0.22 mm and treatment T_5 (20%sewage sludge +80% cocopeat), T_6 (30% sewage sludge +70% cocopeat), and T_7 (control) shows best impact on stem girth. At 75 days 33.33% increase in the stem girth as compared to the 60 days; however the variation in treatments are from 0.18-0.27mm and treatment T_7 (control) shows best impact on stem girth. And also increase the concentration of the potassium 300 ppm increase the growth habitat of plant (Razieh Ebrahimi *et al.*, 2012).

Table.1 Effect of nutrient concentration on the plant height (cm) of strawberry at 15, 30, 45, 60, 75 and 90 days in hydroponic system

Treatment	PH 15	PH 30	PH 45	PH 60	PH 75	PH 90
T1	5.03a±0.26	5.13a±0.21	6.06a±0.37	6.23ab±0.29	6.23ab±0.29	6.23ab±0.29
T2	4.13a±0.14	4.70a±0.11	5.73a±0.08	5.90b±0.11	5.90b±0.11	5.90b±0.11
T3	4.43a±0.49	4.73a±0.55	5.70a±0.43	5.86b±0.50	5.86b±0.50	5.86b±0.50
T4	4.50a±0.70	5.00a±0.80	6.00a±0.77	6.26ab±0.63	6.26ab±0.63	6.26ab±0.63
T5	4.83a±0.58	5.46a±0.57	6.86a±0.26	7.23a±0.20	7.23a±0.20	7.23a±0.20
T6	4.03a±0.68	5.36a±0.56	6.50a±.0.45	6.90ab±0.37	6.90ab±0.37	6.90ab±2.37
T7	3.93a±0.18	5.26a±0.20	6.46a±0.21	6.63ab±0.14	6.63ab±0.14	6.63ab±0.14

PH= Plant Height

Table.2 Effect of nutrient concentration on the stem girth (mm) of strawberry at 15, 30, 45, 60, 75 and 90 days in hydroponic system

Treatment	SG15	SG30	SG45	SG60	SG75	SG90
T1	0.08bc±0.01	0.11a±0.01	0.14ab±0.01	0.16ab±0.02	0.19c±0.02	0.20a±0.01
T2	0.076c±0.01	0.10bc±0.01	0.14ab±0.01	0.16ab±0.02	0.18c±0.02	0.19a±0.02
T3	0.10abc±0.00	0.13abc±0.01	0.15ab±0.02	0.19ab±0.01	0.21bc±0.01	0.22a±0.01
T4	0.07c±0.00	0.08c±0.00	0.12b±0.00	0.15b±0.00	0.18c±0.00	0.19a±0.00
T5	0.12ab±0.00	0.16ab±0.01	0.21a±0.01	0.22a±0.01	0.23abc±0.01	0.24a±0.01
T6	0.13a±0.02	0.17a±0.03	0.19ab±0.03	0.22a±0.01	0.25ab±0.01	0.26a±0.00
T7	0.11ab±0.01	0.16ab±0.02	0.19ab±0.03	0.22a±0.02	0.27a±0.02	0.23a±0.02

SG= Stem Girth

Table.3 Effect of nutrient concentration on the number of leaves/plant of strawberry at 15, 30, 45, 60, 75 and 90 days in hydroponic system

Treatment	LP15	LP30	LP45	LP60	LP75	LP90
T1	2.66c±0.33	4.00c±0.57	6.33b±0.66	10c±0.57	11.33ab±1.20	11.33b±1.20
T2	3.00c±0.00	6.00bc±0.57	7.00b±1.15	9.66c±0.88	8.33b±4.17	11.66b±0.88
T3	4.00c±1.00	6.33bc±0.88	9.00b±0.57	12abc±0.57	13.66ab±0.88	13.66ab±0.88
T4	3.66bc±0.66	5.33c±0.88	9.33b±0.88	10c±0.57	12ab±1.15	12b±1.15
T5	3.00c±0.00	5.66bc±0.33	8.66b±0.88	10.66bc±0.66	11.66ab±0.88	11.66b±0.88
T6	6.33a±0.33	9.33a±1.45	13.33a±1.45	14a±1.52	15.66a±1.20	15.66a±1.20
T7	5.33ab±0.66	8.33ab±0.66	13.00a±0.57	13ab±0.57	10.66ab±2.84	14ab±0.57

LP= Leaves/Plant

Table.4 Effect of nutrient concentration on the leaf area (cm^2) of strawberry at 15, 30, 45, 60, 75 and 90 days in hydroponic system

Treatment	LA15	LA30	LA45	LA60	LA75	LA90
T1	7.93b±1.73	9.80c±1.77	15.63b±2.1	13.13b±2.03	20.80bc±1.43	19.03ab±3.78
T2	9.16b±1.20	16.86bc±1.24	17.16b±0.98	26.83ab±1.58	13.43c±0.38	13.70b±2.21
T3	19.56ab±6.44	22.23abc±6.22	26.36ab±5.52	13.13b±5.57	23.03b±1.18	23.16ab±0.98
T4	21.60ab±5.83	24.73ab±5.26	27.16ab±4.82	20.10ab±2.80	17.66bc±4.17	21ab±5.02
T5	17.13ab±1.54	19.03abc±1.70	20.36b±1.78	15.70ab±1.47	17.10bc±1.15	17.86ab±3.18
T6	28.63a±4.94	29.96a±4.68	33.50a±4.76	24.46a±3.57	21.46bc±3.54	31.33a±9.19
T7	13.46b±2.89	16.43bc±2.91	17.53b±3.25	14.40ab±3.57	34.86a±4.51	20.83ab±5.19

LA= Leaf Area

Table.5 Effect of nutrient concentration on the number of branches/plant of strawberry at 15, 30, 45, 60, 75 and 90 days in hydroponic system

Treatment	NBP15	NBP30	NBP45	NBP60	NBP75	NBP90
T1	1.33bc±0.33	2.00b±0.00	3.00ab±0.57	3.00abc±0.57	3.66b±0.66	3.66b±0.66
T2	1.00c±0.00	2.00c±0.00	2.33b±0.33	2.66bc±0.33	3.33b±0.33	3.33b±0.33
T3	1.33bc±0.33	2.33ab±0.33	2.66b±0.33	3.33abc±0.33	3.66b±0.33	3.66b±0.33
T4	1.33bc±0.33	1.66b±0.33	2.00b±0.00	2.33c±0.33	3.00b±0.57	3.00b±0.57
T5	1.66bc±0.33	2.00b±0.57	3.00ab±0.57	3.33abc±0.33	4.33ab±0.66	4.33ab±0.66
T6	2.66a±0.33	3.32a±0.33	4.33a±0.33	4.33a±0.33	5.33a±0.33	5.33a±0.33
T7	2.00ab±0.00	2.66ab±0.33	3.33ab±0.66	4.00ab±0.57	5.33a±0.33	5.33a±0.33

NBP= Number of Branches/Plant

Table.6 Effect of nutrient concentration on the number of flowers/plant of strawberry at45, 60, 75 and 90 days in hydroponic system

Treatment	NFP45	NFP60	NFP75	NFP90
T1	0.33b±0.33	1.66a±0.33	1.00a±0.57	1.00a±0.57
T2	1.00ab±0.00	0.66a±0.66	1.00a±0.00	1.33a±0.33
T3	0.33b±0.33	1.33a±0.33	1.30a±0.66	1.33a±0.33
T4	0.33b±0.33	1.33a±0.33	1.66a±0.33	2.00a±0.00
T5	0.66ab±0.33	1.00a±0.57	1.33a±0.33	2.00a±0.57
T6	0.66a±0.33	2.00a±0.57	1.66a±0.33	1.66a±0.33
T7	0.66ab±0.33	1.00a±0.57	1.33a±0.66	1.00a±0.66

NFP= Number of flowers/plant

Table.7 Effect of nutrient concentration on the number of fruits/plant of strawberry at 45, 60, 75 and 90 days in hydroponic system

Treatment	NFrP45	NFrP60	NFrP75	NFrP90
T1	0.66ab±0.33	0.66a±0.66	0.66a±0.33	1.33b±0.33
T2	0.33ab±0.33	1.33a±0.33	0.66a±0.33	1.66ab±0.33
T3	1.00a±0.00	0.33a±0.33	1.33a±0.33	1.66ab±0.33
T4	0.33ab±0.33	1.00a±0.00	2.00a±0.57	1.66ab±0.33
T5	0.33ab±0.33	0.66a±0.33	1.00a±0.57	2.66a±0.33
T6	0.66ab±0.33	1.00a±0.00	2.00a±0.00	2.33ab±0.33
T7	0.00b±0.00	0.66a±0.33	1.33a±0.33	1.33b±0.33

NFrP= Number of Fruits/Plant

Table.8 Effect of nutrient concentration on the Yield/Plant of strawberry at 90 days in hydroponic system

Treatment	YP90
T1	10.43c±2.52
T2	14.70bc±1.67
T3	15.50bc±0.98
T4	20.83ab±3.40
T5	20.16ab±1.78
T6	27.83a±4.16
T7	11.83c±1.28

YP= Yield/Plant

Table.9 Effect of nutrient concentration on the harvesting index of strawberry at 90 days in hydroponic system

Treatment	HI90
T1	0.46a±0.10
T2	0.54a±0.01
T3	0.55a±0.03
T4	0.55a±0.06
T5	0.52a±0.01
T6	0.55a±0.04
T7	0.48a±0.04

HI= Harvesting Index

Experimental Details

Period of work: Mid November to march 2017
Treatment: 7
Replication: 3
Total number of plot: 7x3=21
Design: Wooden box Block design Structure
Variety: Chandler
Seed rate: Planting seedling
Date of transplanting: 3 Nov, 2016
Method of fertilizer application: Nutrient solution (Hoagland)
Method and time of irrigation: Twice a week
Date of flowering: 18, Nov 2016
Date of Fruiting: 25, Nov 2016

Details of Treatment

T_1 = 10% Tea Extract (Dry) + 90% Cocopeat
T_2 = 20% Tea Extrac (Dry)t + 80% Cocopeat
T_3 = 30% Tea Extract (Dry) + 70% Cocopeat
T_4 = 10% Sewage sludge + 90% Cocopeat
T_5 = 20% Sewage sludge + 80% Cocopeat
T_6 = 30%Sewage sludge + 70% Cocopeat
T_7 = Control

At 15 days, in between the treatment 57.97% increase in the leaf/plant; At 30 days 42.87% increase; At 45 days 52.51% increase in leaf/plant; At 60 days 28.57% increase; At 75 days 46.80% increase; At 90 days 27.65% increase in leaf/plant respectively. At 30days leaf/plant observation shows 32.15% increase as compared to leaf/plant at 15days; however the variation is treatment are from 5.33-9.33 and T_6 (30%sewage sludge+ 70% cocopeat) shows best impact on leaf/plant. It depends on the increase the cocopeat perlite ratio increase chlorophyll a and b in leaf and shows the best growth of plants. (Masaru Sakamoto *et al.*, 2016). At 45days leaf/plant observation shows 30% increases as compared to the 30days; however the variation in treatments are from 9-13.33 and treatment T_6 (30% sewage sludge + 70% cocopeat) shows the best impact on the leaf/plant. The number of leaves depends on the time of transplanting and the runner tips. If runners will less that number of leaves will also become less in plants (Carine *et al.*, 2010). At 60 days leaf/plant observation shows the 4.78 % increase in the leaf/plant; however the variation in treatment are 10-14 and treatment T_6 shows the best impact on the leaf/plant. At 75 days leaf/plant shows observation 10.60% increase as compared to the 60days; however the variation in treatment are from 8.33-15.66 and treatment T_6 (30% sewage sludge +70% cocopeat) shows best impact on the leaf/plant. In between treatment, at 15days 68% increase in leaf area; At 30days 67.28% increase; At 45days 48.77% increase in leaf area; At 60 days 46.32% increase in leaf area; At 75 days 33.93% increase in leaf area respectively. And at 90 days 56.27% increase in leaf area. At 30days, leaf area observation shows 4.43% increase as compared to 15days; however the variation in treatments are from 9.80-29.96 square centimeter and treatment T_6(30%sewage sludge + 70% cocopeat) shows best impact on leaf area. At 45 days, leaf area observation shows 10.56% increase as compared to 30 days; however the variation of leaf area in treatments are from 17.16-33.50 square centimeter and treatment T_6 (30% sewage sludge + 70% cocopeat) shows best impact on leaf area. Two part of perlite, one part of date palm and one part of cocopeat showed the good leaf area (Razieh Ebrahimi *et al.*, 2012). At 60 days, leaf area observation shows 36.95% increase as compared to 45days; however the variation in treatments are from 13.13-24.46 square centimeter and treatment T_6 (30%sewage sludge + 70% cocopeat) shows best impact on leaf area. The two part of perlite, part of date palm and one part of cocopeat shows the best impact on the leaf area (Abdolali Hesami *et al.*, 2012). At 75 days, leaf area observation shows 58.69% increase as compared to 60 days; however the variation in treatments are from 13.43-34.86 square centimeter and treatment T_7 (control) shows best impact on leaf area. At 90 days, leaf area observation shows 31.50% increase as compared to 75 days; however the variation in treatments are from 13.70-31.33 square centimeter and treatment T_6 (30%sewage sludge + 70% cocopeat) shows best impact on leaf area. It is due to the EC factor when the EC was

increase 1.0 dS m^{-1} it increase the leaf area in some cultivar like 'Goha' (Young Hun Lee *et al.,* 2015).

In between treatment, at 15days 62.04% increase in number of branch/plant; At 30 days 39.75% increase; At 45 days 53.81% increase in number of branch/plant; At 60 days 46.18 % increase in number of branch/plant; At 75 days 43.71% increase in number of branch/plant respectively. And At 90 days 43.71% increase in number of branch/plant. At 30 days, number of branch/plant observation shows 19.87% increase as compared to 15 days; however the variation in treatments are from 2-3.32 branches and treatment T_6 (30%sewage sludge + 70% cocopeat) shows best impact on number of branch /plant. Some researcher tells that with the high cocopeat ratio result in high chlorophyll a and b. it increase the leaf weight and crown in the plants (S. Afsharipoora *et al.,* 2010). At 45 days, number of branch/plant observation shows 23.32% increase as compared to 30 days; however the variation in treatments are from 2.33-4.33 branches and treatment T_6 (30%sewage sludge + 70% cocopeat) shows best impact on number of branch /plant. At 75 days, number of branch/plant observation shows 18.76 % increase as compared to 60 days; however the variation in treatments are from 3.33-5.33 branches and treatment T_6 (30%sewage sludge + 70% cocopeat) shows best impact on number of branch /plant. At 90 days flower/plant observation shows that the 50% increase as compare to the 75 days; however the variation is from 1.33-2.66 flowers and treatment T_5 (20% sewage sludge +80% cocopeat) shows the best impact on the flower/plant. Some researcher tells that number of flower increase due to increase in perlite using 25% perlite + 75 % cocopeat (Afsharipoor *et al.,* 2010). At 90 days 50% increase in the number of fruits/plant as compared the 75 days: however the variation is from 1.33-2.33 fruits and the T_6 shows the best impact on the fruits/plant. Some worker worked on the elevation and tells about it depends on where the plants is grown and depends on the root temperature zone. The good quality of fruits is observed at 10 to 30 degree temperature (Masaru *et al.,* 2016). In between the treatment at 90 days, 62.52% of yield/plant increase. Some researcher (Young Hun Lee *et al.,* 2015) said that the yield depends on the variety also like Albion, the increase yield due to the change 1EC 1dS m^{-1}. But in 'Goha' Varity yield is decrease with increase in the EC. After harvesting the crop the harvesting index shows the 16.01% change in between the treatment. And the variation is from 0.46-0.55 HI and T_6 (30% sewage sludge + 70% cocopeat) shows the largest harvesting index. It is due the sometimes changing in EC from 0.5 to 1 dS m^1 (Young Hun Lee *et al.,* 2016).

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