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Comparative performance of different wheat-grass production techniques under greenhouse condition

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Abstract

For year round supply of fodder three techniques of wheat-grass production under protected environment were compared. Hydroponics fodder provides natural way to provide nutrients for the animals and plays major role in livestock health and overall growth. Hydroponics fodder actually plays a major role in feed of the milch animals. In Pakistan year-round fodder availability is very important especially in slack period. Nutrient film technique is an improved method to grow wheat-fodder without soil by using nutrients water in channels. The process of growing wheat-fodder hydroponically allows the control of climatic conditions for optimum growth. In hydroponics agriculture, only two weeks are required for the harvesting of wheat-grass due its fast growing habit under protected environment. Keeping in view the importance of fodder, an experiment was conducted at Hydroponic Research Station Rawat, Institute of Hydroponic Agriculture (IHA), PMAS Arid Agriculture University Rawalpindi. The experiment conducted for two size of re-circulating PVC pipes (7.6 and 10.1 cm dia) and steel trays (8.8 and 12.5 cm width) while their comparison was made with drip irrigation system and pasteurized soil for wheat-grass production. Five clusters were selected from each Channel and data recorded for various crop growth parameters like germination rate, cluster height, number of tillers, root length, fresh weight and dry weight was statistical analyzed by using Complete Randomized Design (CRD). It was concluded from the study that NFT proved to be a better technique as compared to drip and pasteurized soil.

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Introduction

The frequent draught and flood are main reasons of climate change. Soil infertility is another reason in many countries which decreases food production as fertilizers and irrigation becomes unreachable (Okemwa, 2015). Many reports revealed the benefits of hydroponics agriculture over traditional farming due to the many elements i.e. decrease of work, high yields, quantity and quality because of the more uniform states of plants development (Mason, 1990). Nutrient Film Technique is a technique of soilless culture in which nutrients rich water circulates through the system either pipes or trays by submersible water pump without a time control (Domingues *et al.,* 2012).

The growing of plants without soil is called hydroponics and it is done by using a nutrient solution (Resh, 2013). Generally, NFT consist of re-circulating channels which consist of supports in which nutrients solution is applied. The channels are formed from many types of plastics (PVC pipes or steel trays) that are hollow and allow for UV protection (Kellie, 2015). There are two types of nutrient film technique: static and re-circulating. While these hydroponics types may include many aspects, including design, they fundamentally differ in order to manage the nutrient solution (Kruchkin, 2013). Re-circulating system reuse the nutrient water via recirculation through proper channel. The nutrient water is monitored regularly. pH, EC and nutrient water volume are important factors in the development of re-circulating system. As compare to the static system, re-circulating NFT system conserve nutrient water, which reduces waste. Re-circulating system can conserve 20-40% nutrient water than static system, but monitoring and maintenance of re-circulating system is difficult (Macabo *et al.*, 2013).

In re-circulating NFT system, nutrient water can easily collected at the end of the channel, fall in the bucket, and apply again to the plant roots. In re-circulating system the nutrient water will need regular monitoring in order to maintain composition of nutrients (Fenneman, 2013). Nutrient film technique can effectively use for wheat grass production under protected environment free of insecticides, herbicides, fungicides. It is a familiar technique for fodder production with less nutrients and water consumption. (Al-Karaki, 2011). Yvonne Kamanga (2016) describes that hydroponic fodder has been produced in a simple greenhouse containing wooden frame shelving on which trays containing seeds are stacked. Water conservation, year-round production, increasing yields, and nutrients conservations are among the various advantages of NFT. Hydroponic plants can generally be planted closer together with high density compared to the conventional plants (Resh & Howard, 2012).

Soil infertility and erosion due to old-style growing techniques generally resulted in nutrients imbalance of the soil. The final result of Nutrient Film Technique is greater yields and high-quality production over old cultivation techniques (Nelson, 2012).

Materials and methods

Study area

Experiment was conducted at Hydroponic Research Station, Institute of Hydroponic Agriculture, PMAS-Arid Agriculture University Rawalpindi during the year 2018-19. Study area falls in the jurisdiction of district Rawalpindi *Pothwar* region of North Punjab, Pakistan.

Experimental Design

NFT consists of two sizes of re-circulating PVC pipes (7.6 and 10.1 cm dia) and steel trays (8.8 and 12.5 cm) while their comparison was made with drip irrigation system and pasteurized soil. Polystyrene trays were fitted in the rectangular holes (1'×6") on PVC pipes, trays and coco slabs. Rockwool was used as a supporting media placed in the polystyrene trays. For optimum growth of wheat-grass air and submersible water pumps were used to provide required amount of oxygen and re-circulation of water in the channels to maintain EC & pH of nutrient solution. EC and pH of nutrient water was maintained 1.5dS/m and 5.5. However the mode of irrigation for coco slab was drip while pasteurized soil was manually irrigated with recipe water. For comparative performance of wheat-grass in soil, Plastic pots were used as carrier.

Experimental Treatments

Experiment consist of T_1 (re-circulating pipe 7.6 cm dia.), T_2 (re-circulating pipe 10.1 cm dia.), T_3 (re-circulating tray 8.8 cm width), T_4 (re-circulating tray 12.5 cm width), T_5 (Drip irrigation system), T_6 (Pasteurized soil). Five clusters were selected from each treatment and data recorded from each treatment was statistically analyzed.

Results and discussions

Experiment was conducted for comparison of re-circulating NFT with drip irrigation system and pasteurized soil under protected environment. Data recorded during study was statistical analyzed by using Completely Randomized Design (CRD) with the help of appropriate software Statistic 8.1 at 5% level of probability. Measuring variables including; germination rate, cluster height, number of tillers, root length, fresh weight and dry weight are discussed as;

Germination rate (%)

Mean germination rate (Table 1) in treatment T_1, T_2, T_3, T_4, T_5 and T_6 was observed 37.0, 64.4, 81.0, 91.4, 89.6 and 68.8 % respectively. Maximum germination rate (91.4%) was observed in treatment (T_4) re-circulating steel tray with 12.5 cm width, Second highest germination rate (89.6%) was observed in treatment (T_5) drip irrigation system while minimum germination rate (37.0 %) was observed in treatment (T_1) re-circulating pipe with 7.6 cm dia.

Results showed that treatment (T_4) re-circulating steel tray with 12.5 cm width was non-significant with treatment (T_5) drip irrigation system while it significantly differ with treatment (T_1) Static pipe with 7.6 cm, treatment (T_2) Static pipe with 10.1 cm, (T_3) re-circulating steel tray (8.8 cm width)and treatment (T_6) pasteurized soil at 5% level of probability The mean value of germination rate was at par with the findings of (Khoneva *et al.,* 2018) who reported that maximum germination rate (93%) was observed in soilless agriculture.

Cluster height (cm)

Mean cluster height (Table 2) in treatment T_1, T_2, T_3, T_4, T_5 and T_6 was observed 21.6, 28.6, 36.0, 40.8, 37.2 and 34.6cm respectively. Maximum cluster height (40.8cm) was measured in treatment (T_4) re-circulating steel tray with 12.5 cm width, Second highest cluster height (37.2cm) was observed in treatment (T_5) drip irrigation system while minimum cluster height (21.6cm) was measured in treatment (T_1) re-circulating pipe with 7.6 cm dia.

Results showed that treatment (T_4) Steel tray with 12.5 cm width was non-significant with treatment (T_5) drip irrigation system while it significantly differ with treatment (T_1) Static pipe with 7.6 cm, treatment (T_2) Static pipe with 10.1 cm, (T_3) Steel tray with 8.8 cm width and treatment (T_6) pasteurized soil at 5% level of probability. In the present experiment, cluster height in treatments T_1 and T_2 were in line with the findings of Naik *et al.*, 2015 who reported that wheat-grass fodder height was 20-30cm.

Table 1. Effect of different treatments on germination rate.

Treatments	Germination rate (%)
T_1 Re-circulating pipe (7.6 cm)	37.0 d
T_2 Re-circulating pipe (10.1 cm)	64.4 c
T_3 Re-circulating steel tray (8.8 cm width)	81.0 b
T_4 Re-circulating Steel tray (12.5 cm width)	91.4 a
T_5 Drip irrigation system (Coco slab)	89.6 a
T_6 Pasteurized soil (Pots)	68.8 c
LSD	8.5

Mean with similar letters are statistically non-significant at 5% level of probability.

Table 2. Effect of different treatments on cluster height.

Treatments	Cluster height (cm)
T_1 Re-circulating pipe (7.6 cm)	21.6 d
T_2 Re-circulating pipe (10.1 cm)	28.6 c
T_3 Re-circulating Steel tray (8.8 cm width)	36.0 b
T_4 Re-circulating Steel tray (12.5 cm width)	40.8 a
T_5 Drip irrigation system (Coco slab)	37.2 ab
T_6 Pasteurized soil (Pots)	34.6 b
LSD	4.5

Mean with similar letters are statistically non-significant at 5% level of probability.

Number of tillers (No.)

Mean number of tillers (Table 3) in treatment T_1, T_2, T_3, T_4, T_5 and T_6 was observed 89.0, 162.6, 188.0, 217.8, 187.8 and 157.6 respectively. Maximum number of tillers (217.8) was observed in treatment (T_4) re-circulating steel tray with 12.5 cm width, Second highest number of tillers (188.0) was observed in treatment (T_3) re-circulating steel tray with 8.8 cm width while minimum number of tillers (89.0) was observed in treatment (T_1) re-circulating pipe with 7.6 cm.

Results showed that treatment (T_4) re-circulating steel tray with 12.5 cm width was significant with treatment (T_1) Static pipe with 7.6 cm , treatment (T_2) Static pipe with 10.1 cm treatment (T_3) re-circulating steel tray with 8.8 cm width, (T_5) drip irrigation system and treatment (T_6) pasteurized soil at 5% level of probability.

Table 3. Effect of different treatments on number of tillers.

Treatments	number of tillers
T_1 Re-circulating pipe (7.6 cm)	89.0 d
T_2 Re-circulating pipe (10.1 cm)	162.6 c
T_3 Re-circulating Steel tray (8.8 cm width)	188.0 b
T_4 Re-circulating Steel tray (12.5 cm width)	217.8 a
T_5 Drip irrigation system (Coco slab)	187.8 b
T_6 Pasteurized soil (Pots)	157.6 c
LSD	19.7

Mean with similar letters are statistically non-significant at 5% level of probability.

Root length (cm)

Mean root length (Table 4) in treatment T_1, T_2, T_3, T_4, T_5 and T_6 was observed 4.4, 10.4, 12.8, 18.8, 13.6 and 12.2cm respectively. Maximum root length (18.8cm) was observed in treatment (T_4) re-circulating steel tray with 12.5 cm width. Second highest root length (13.6cm) was observed in treatment (T_5) drip irrigation system while minimum root length (4.4cm) was observed in treatment (T_1) re-circulating pipe with 7.6 cm dia.

Results showed that treatment (T_4) re-circulating steel tray with 12.5 cm was significantly differ with treatment (T_1) Static pipe with 7.6 cm, treatment (T_2) Static pipe with 10.1 cm , treatment (T_3) Steel tray with 8.8 cm width, treatment (T_4) re-circulating steel tray with 12.5 cm (T_5) drip irrigation system and (T_6) pasteurized soil at 5% level of probability. The mean value of root length in treatment (T_4) is in-line with the findings of Donald Wetherell (1988) who reported that hydroponically grown wheat root system develops 15-25cm.

Table 4. Effect of different treatments on root length.

Treatments	Root length (cm)
T_1 Re-circulating pipe (7.6 cm)	4.4 d
T_2 Re-circulating pipe (10.1 cm)	10.4 b
T_3 Re-circulating Steel tray (8.8 cm width)	12.8 bc
T_4 Re-circulating Steel tray (12.5 cm width)	18.8 a
T_5 Drip irrigation system (Coco slab)	13.6 c
T_6 Pasteurized soil (Pots)	12.2 bc
LSD	2.5

Mean with similar letters are statistically non-significant at 5% level of probability.

Fresh weight (g)

Mean fresh weight (Table 5) in treatment T_1, T_2, T_3, T_4, T_5 and T_6 was observed 224.0, 372.0, 460.0, 550.0, 506.0 and 388 gram respectively. Maximum fresh weight (550g) was measured in treatment (T_4) re-circulating steel tray with 12.5 cm width, Second highest fresh weight (506g) was measured in (T_5) drip irrigation system while minimum fresh weight (224g) was measured in treatment (T_1) Static pipe with 7.6 cm.

Results showed that treatment (T_4) Steel tray with 12.5 cm width was non-significant with treatment (T_5) drip irrigation system while it significantly differ with treatment (T_1) re-circulating pipe with 7.6 cm, treatment (T_2) re-circulating pipe with 10.1 cm, (T_3) re-circulating steel tray with 8.8 cm width and treatment (T_6) pasteurized soil at 5% level of probability.

Table 5. Effect of different treatments on fresh weight.

Treatments	Fresh weight (g)
T_1 Re-circulating pipe (3")	224 d
T_2 Re-circulating pipe (4")	372 c
T_3 Re-circulating steel tray (4.5" width)	460 b
T_4 Re-circulating steel tray (10.8" width)	550 a
T_5 Drip irrigation system (Coco slab)	506 ab
T_6 Pasteurized soil (Pots)	388 c
LSD	46.9

Mean with similar letters are statistically non-significant at 5% level of probability.

Dry weight (g)

Mean dry weight (Table 6) in treatment T_1, T_2, T_3, T_4, T_5 and T_6 was observed 96, 144, 188, 224, 206 and 160 gram respectively. Maximum dry weight (224g) was observed in treatment (T_4) re-circulating steel tray with 12.5 cm width, Second highest dry weight (206g) was observed in (T_5) drip irrigation system while minimum dry weight (96 g) was observed in treatment (T_1) re-circulating pipe with 7.6 cm.

Results showed that treatment (T_4) Steel tray with 12.5 cm width was non-significant with treatment (T_5) drip irrigation system, while it significantly differ with treatment (T_1) Static pipe with 7.6 cm, treatment (T_2) Static pipe with 10.1 cm, (T_3) Steel tray with 8.8 cm width and treatment (T_6) pasteurized soil at 5% level of probability. On an average weight loss in dehydrating fresh fodder was observed about 60 %, which is at par with Chung *et al.* (1989) who concluded that dry weight losses were 9.4-18 %.

Table 6. Effect of different treatments on dry weight.

Treatments	Dry weight (g)
T_1 Re-circulating pipe (7.6 cm)	96 d
T_2 Re-circulating pipe (10.1 cm)	144 c
T_3 Re-circulating Steel tray (8.8 cm width)	188 b
T_4 Re-circulating Steel tray (12.5 cm width)	224 a
T_5 Drip irrigation system (Coco slab)	206.0 ab
T_6 Pasteurized soil (Pots)	160 c
LSD	25.7

Mean with similar letters are statistically non-significant at 5% level of probability.

Conclusions

It was concluded from the study that NFT has higher production of wheat-grass fodder as compared to the drip irrigation system and pasteurized soil as it has highest germination rate, cluster height, number of tillers, root length, fresh weight and dry weight were obtained in treatment (T_4) steel tray with 12.5 cm width in greenhouse conditions.

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