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Quality of different crops under hydroponics fodder production system

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Abstract

The experiment was conducted at new area Farm, Department of Forage crops, Tamil Nadu Agricultural University, Coimbatore, to evaluate the quality of different crops under hydroponics fodder production system during October-December 2017. The treatment consist of fodder maize, grain maize, fodder bajra, grain bajra, barley, wheat, oats, fodder cowpea, grain cowpea, horse gram, soybean and Lucerne. Among the different crops under study, fodder maize, grain maize, grain cowpea and horse gram found to possess quality fodder under hydroponics fodder production system and recorded higher shoot length, chlorophyll index, total protein content, total protein yield, crude fat content and crude fat yield. These crops were followed by fodder cowpea.

Keywords: Hydroponics, shoot length, chlorophyll content, total protein, crude fat

Introduction

Green fodder produced by growing seeds without soil but in water or nutrient rich solutions is known as hydroponics green fodder. Hydroponics green fodders are mostly produced in green house under controlled environment. For commercial purpose to feed livestock, it started in 1960's in Australia and has spread to the rest of the world ever since. Hydroponics sprouts may have profitable application in intensive, small-scale livestock situations with high value outputs, where land and alternative feed costs are high, and where the quality changes (less starch, more lysine, vitamins, etc.) due to sprouting are advantageous to the particular livestock. Hydroponics fodder is more nutritious than the conventional maize (Naik *et al*, 2013) [12] fodder; as it contains more crude protein (13.30-13.60 vs. 10.70-11.14; per cent). Besides, hydroponics fodder has more potential health benefits. Sprouts are the most enzyme rich food on the planet and the period of greatest enzyme activity is generally between germination and 7 days of age (Finney, 1982) [5]. They are rich source of anti-oxidants in the form of β-carotene, vitamin-C, E and related trace minerals such as selenium and Zn. As sprouted grains are rich in enzymes and enzyme-rich feeds are generally alkaline in nature, feeding of the sprouted grains improve the animals' productivity by developing a stronger immune system due to neutralization of the acidic condition (Chavan and Kadam, 1989) [3]. Besides, helping in the elimination of the anti-nutritional factors such as phytic acid of the grains; sprouted grains are good sources of chlorophyll and contain a grass juice factor that improves the performance of the livestock (Sneath and Mclntosh, 2003; Shipard, 2005) [15, 14]. Keeping these in view, the present study was mooted with assessment of quality of green fodder produced by different crops through hydroponics.

Materials and Methods

The experiment was conducted at 'F' block of new area Farm, Department of Forage crops, Tamil Nadu Agricultural University, Coimbatore, during October-December 2017. The experimental site located in the western agro climatic zone of Tamil Nadu at 11 ºN latitude and 77 ºE longitudes and at an altitude of 426.7m above the mean sea level. The experiment was laid out in completely randomized design comprised three replications and twelve treatments *viz.*, fodder maize, grain maize, fodder bajra, grain bajra, barley, wheat, oats, fodder cowpea, grain cowpea, horse gram, soybean and lucerne. And the experiment repeated by four times. Low cost hydroponic chamber having the size of 20' length x 10' width x 10' height was established with available once used GI pipes and wooden reapers. The shill out was covered with shade net of 70 percent shading capacity. Wooden racks (10' length x3' width x 5' height) were fabricated to hold the hydroponic plastic trays (1260cm2). Drainage holes were made at the bottom of trays to facilitate drainage of excess water. Single phase half HP motor was used to deliver the water from water tank through 16mm laterals fitted with low cost foggers at 75cm distance.

Observations on shoot and root length were taken on 2^{nd}, 4^{th}, 6^{th}, and 8^{th} day of seeding of crops, respectively. The chlorophyll index (SPAD meter readings) was recorded from 3^{rd} day to 8^{th} day of crop growth. Quality parameter such as total nitrogen content was estimated by micro Kjeldahl's method suggested by Humphries (1956) [9] and it was multiplied by the factor 6.25 to obtain the total protein content. It was expressed in percentage. Total protein yield was computed by multiplying the total protein content with the respective dry matter production and expressed in g kg^{-1} of seeds. Crude fat content was determined according to the method of A.O.A.C (1970) [1] and expressed in percentage. Crude fat yield was computed by multiplying the fat content with the respective dry matter production and expressed in g kg^{-1} of seeds. The cost of cultivation, gross return, net return and benefit cost ratio were calculated on the basis of prevailing market price of different inputs and outputs. Observations from four trials were subjected to pooled data analysis technique, the pooled data were statistically analyzed based on the procedure given by Gomez and Gomez (1984) [6]. Pooled and individual trial wise data for the parameters *viz*., nitrogen content, total protein content, total protein yield, crude fat content, crude fat yield, are detaily furnished. While, pooled data for the parameters *viz*., shoot length, chlorophyll index are given.

Results and Discussion

Shoot length

The results revealed (Table. 1) that significantly higher shoot length was recorded in fodder maize (3.17, 10.08, 19.76 and 25.12cm) at different stages (2^{nd}, 4^{th}, 6^{th}, and 8^{th} day) of observation, respectively. It was on par with grain maize (3.12, 9.80, 19.22 and 24.87cm), grain cowpea (3.10, 9.84, 19.29 and 24.84cm) and horse gram (3.08, 9.73, 19.11 and 24.77 cm) at different stages (2^{nd}, 4^{th}, 6^{th}, and 8^{th} day) of observation. However, significantly lower shoot length was observed in soybean (1.08, 3.98, 7.66 and 0.00cm) and lucerne (1.01, 3.79, 0.00 and 0.00cm) at different stages (2^{nd}, 4^{th}, 6^{th}, and 8^{th} day) of observation, respectively. The variation in shoot length of different crops under hydroponics has been reported Mooney (2005) [11].

Table 1: Effect of different crops on shoot (cm) under hydroponics

Treatments	Shoot length			
	2^{nd}	4th	6th	8th
C_1-Fodder maize	3.17	10.08	(1.31)	(1.42)
			19.76	25.12
C_2-Grain maize	3.12	9.80	(1.30)	(1.41)
			19.22	24.87
C_3-Fodder bajra	1.85	5.38	(1.07)	(1.20)
			10.66	14.80
C_4-Grain bajra	1.82	5.30	(1.06)	(1.20)
			10.53	14.70
C_5-Barley	2.23	6.98	(1.19)	(1.29)
			14.48	18.43
C_6-Wheat	2.21	6.93	(1.19)	(1.29)
			14.41	18.40
C_7-Oat	2.20	6.91	(1.19)	(1.29)
			14.38	18.36
C_8-Fodder cowpea	2.68	8.33	(1.25)	(1.35)
			16.70	21.65
C_9-Grain cowpea	3.10	9.84	(1.30)	(1.41)
			19.29	24.84
C_{10}-Horse gram	3.08	9.73	(1.30)	(1.41)
			19.11	24.77
C_{11}-Soybean	1.08	3.98	(0.93)	(0.00)
			7.66	0.00
C_{12}-Lucerne	1.01	3.79	(0.00)	(0.00)
			0.00	0.00
SEd	0.05	0.19	0.01	0.01
CD (P=0.05)	0.11	0.40	0.02	0.02

Figures in parenthesis are log transformed

Quality parameter

Chlorophyll index (SPAD reading)

Results showed that there was a remarkable variation in leaf nitrogen content (chlorophyll index) due to different crops studied under hydroponics fodder cultivation system (Table. 2). During3^{rd} and 4^{th} day of seeding there was no significant difference was observed between fodder maize (C_1) (22.31 and 24.87, respectively), grain maize (C_2) (22.19 and 24.86, respectively), fodder bajra (C_3) (22.08 and 24.85, respectively), grain bajra (C_4) (21.99 and 24.82, respectively), barley (C_5) (22.31 and 24.71, respectively), wheat (C_6) (22.19 and 24.62, respectively) and oats (C_7) (22.07 and 24.85, respectively), fodder cowpea (C_8) (22.23 and 25.64, respectively), grain cowpea (C_9) (22.29 and 25.09 at 3^{rd} and 4^{th}, respectively) and horse gram (C_{10}) (22.25 and 25.06 at 3^{rd} and 4^{th}, respectively) registered significantly higher chlorophyll index. In general, all the crops were significantly superior over soybean (C_{11}) (12.76, and 13.49 at 3^{rd} and 4^{th} day of seeding, respectively) and lucerne (C_{12}) (12.57, and 13.37 at 3^{rd} and 4^{th} day of seeding, respectively) these findings are in concordance with Wood *et al.* (1992) [18].

Remaining crop growth periods, grain cowpea (C_9) (34.15, 36.28, 38.25, and 39.30 at 5^{th}, 6^{th}, 7^{th}, and 8^{th} day of seeding, respectively), horse gram (C_{10}) (34.13, 36.36, 38.27, and 39.28 at 5^{th}, 6^{th}, 7^{th}, and 8^{th} day of seeding, respectively) and fodder cowpea (C_8) (34.06, 36.20, 38.11, and 39.10 at 5^{th}, 6^{th}, 7th, and 8th day of seeding, respectively) were recorded significantly higher chlorophyll index values and were on par with each other. And the above mentioned crops were followed by fodder maize (C_1), recorded chlorophyll index value of 27.21, 30.03, 32.18, and 33.78 at 5th, 6th, 7th, and 8th day of seeding, respectively. grain maize (C_2) (27.17, 30.01, 32.07, and 33.58 at 5th, 6th, 7th, and 8th day of seeding, respectively), fodder bajra (C_3) (26.92, 29.03, 31.93, and 32.87 at 5th, 6th, 7th, and 8th day of seeding, respectively), grain bajra (C_4) (27.03, 29.86, 31.84, and 32.86 at 5th, 6th, 7th, and 8th day of seeding, respectively), barley (C_5) (27.13, 29.76, 31.82, and 32.90 at 5th, 6th, 7th, and 8th day of seeding, respectively), wheat (C_6) (27.23, 29.82, 31.89, and 32.80 at 5th, 6th, 7th, and 8th day of seeding, respectively) and oats (C_7) (27.03, 29.66, 31.84, and 32.76 at 5th, 6th, 7th, and 8th day of seeding, respectively). However, Lucerne recorded nil values of chlorophyll index from 5th day onwards and soybean registered the nil values from 7th day onwards. Similar, observations were also made by Haboudane *et al.* (2002) [7].

Table 2: Effect of different crops on chlorophyll index under hydroponics

Chlorophyll index					
3rd Day	4th Day	5th Day	6th Day	7th Day	8th Day
		(1.45)	(1.49)	(1.52)	(1.54)
22.31	24.87	27.21	30.03	32.18	33.78
		(1.45)	(1.49)	(1.52)	(1.54)
22.19	24.86	27.17	30.01	32.07	33.58
		(1.45)	(1.48)	(1.52)	(1.53)
22.08	24.85	26.92	29.03	31.93	32.87
		(1.45)	(1.49)	(1.52)	(1.53)
21.99	24.82	27.03	29.86	31.84	32.86
		(1.45)	(1.49)	(1.52)	(1.53)
22.31	24.71	27.13	29.76	31.82	32.90
		(1.45)	(1.49)	(1.52)	(1.53)
22.19	24.62	27.23	29.82	31.89	32.80
		(1.45)	(1.49)	(1.52)	(1.53)
22.07	24.85	27.03	29.66	31.84	32.76
		(1.54)	(1.57)	(1.59)	(1.60)
22.23	25.64	34.06	36.20	38.11	39.10
		(1.55)	(1.57)	(1.59)	(1.61)
22.29	25.09	34.15	36.28	38.25	39.30
		(1.55)	(1.57)	(1.59)	(1.61)
22.25	25.06	34.13	36.36	38.27	39.28
		(1.22)	(1.29)	(0.00)	(0.00)
12.76	13.49	15.63	18.69	0.00	0.00
		(0.00)	(0.00)	(0.00)	(0.00)
12.57	13.37	0.00	0.00	0.00	0.00
0.72	0.72	0.01	0.01	0.01	0.01
1.50	1.50	0.02	0.02	0.02	0.02

Figures in parenthesis are to log transformed

Total protein content

Total protein content was varied significantly due to different crops under hydroponic fodder production system (Table 3). Among the crops studied, higher total protein content of17.59, 18.54, 18.66, and 18.76, per cent on first, second, third, and fourth trial, respectively were registered in horse gram (C_{10}). It was on par with grain cowpea (C_9)with total protein content of17.58, 18.29, 18.56 and 18.64 per cent on first, second, third, and fourth trial, respectively. The above mentioned crops were followed by fodder cowpea (C_8), which recorded 16.12, 16.11, 16.15 and 15.87 per cent of total protein on first, second, third, and fourth trial, respectively. However, among all the crops, lucerne and soybean, registered the nil total protein content in all the four trials.

Pooled analysis also revealed that horse gram (C_{10}) and grain cowpea (C_9) recorded significantly higher total protein content of 18.39 and 18.27 per cent, respectively. It was followed by fodder cowpea (C_8) with 16.06 per cent of total protein content. Similar, results were also observed in the study conducted by Hassan (2013) and Thadchanamoorthy and Pramalal (2012) [17].

Table 3: Effect of different crops on total protein content (per cent) under hydroponics

Treatments trial	Total protein content				
	First	Second	Third	Fourth	Pooled mean
C_1-Fodder maize	(22.43)	(22.61)	(22.21)	(22.50)	(22.44)
	14.56	14.78	14.32	14.64	14.58
C_2 -Grain maize	(22.36)	(22.58)	(22.22)	(22.45)	(22.41)
	14.51	14.75	14.30	14.61	14.54
C_3-Fodder bajra	(15.51)	(15.57)	(15.72)	(15.68)	(15.63)
	7.17	7.21	7.34	7.32	7.26
C_4-Grain bajra	(14.73)	(15.32)	(15.77)	(15.59)	(15.36)
	6.47	6.98	7.39	7.22	7.02
C_5-Barley	(21.03)	(20.77)	(20.93)	(20.75)	(20.88)
	12.88	12.59	12.76	12.56	12.70
C_6-Wheat	(20.92)	(20.73)	(21.03)	(20.94)	(20.91)
	12.78	12.56	12.88	12.78	12.75
C_7-Oat	(20.38)	(20.48)	(20.66)	(20.85)	(20.60)
	12.13	12.25	12.45	12.68	12.38
C_8-Fodder cowpea	(23.67)	(23.66)	(23.69)	(23.47)	(23.63)
	16.12	16.11	16.15	15.87	16.06
C_9-Grain cowpea	(24.78)	(25.32)	(25.49)	(25.57)	(25.30)
	17.58	18.29	18.56	18.64	18.27
C_{10}-Horse gram	(24.78)	(25.49)	(25.58)	(25.66)	(25.39)
	17.59	18.54	18.66	18.76	18.39
C_{11}-Soybean	(0.48)	(0.48)	(0.48)	(0.48)	(0.48)
	0.00	0.00	0.00	0.00	0.00
C_{12}-Lucerne	(0.48)	(0.48)	(0.48)	(0.48)	(0.48)
	0.00	0.00	0.00	0.00	0.00
SEd	0.70	0.57	0.64	0.58	0.36
CD (P=0.05)	1.45	1.19	1.32	1.19	0.74

Figures in parenthesis are to log transformed

Total protein yield

Different crops had a significant impact on total protein yield. (Table 4 & Fig. 1) Among all the crops, horse gram (C_{10}) recorded higher total protein yield of118.45, 128.47, 120.74 and 139.92g TPY kg^{-1} of seeds during first, second, third and fourth trial, respectively. It was on par with grain cowpea (C_9) having the total protein yield of118.45, 128.47, 120.74 and 139.92 g TPY kg^{-1} of seeds during first, second, third and fourth trial, respectively. These crops were followed by fodder maize (C_1) with 100.47, 110.19, 98.23 and 111.48 g TPY kg^{-1} of seeds during first, second, third and fourth trial, respectively and grain maize (C_2) with98.30, 107.30, 95.89 and 108.75 g TPY kg^{-1} of seeds during first, second, third and fourth trial, respectively. However, among all the crops, soybean (C_{11}) and lucerne (C_{12}), registered the nil total protein yield in all the four trials.

Pooled analysis of total protein yield also showed the similar result as obtained from individual trials. In which, horse gram (C_{10}) and grain cowpea (C_9) recorded with significantly higher protein yield of 126.89 and 126.55g TPY kg^{-1} of seeds, respectively. This was followed by fodder maize (C_1) with 105.09 g TPY kg^{-1} of seeds and grain maize (C_2) with 102.56 g TPY kg^{-1} of seeds. This is in agreement with findings of Dung *et al.* (2010) [4].

Table 4: Effect of different crops on total protein yield (g TPY kg-1 of seeds) under hydroponics

Total protein yield				
First	**Second**	**Third**	**Fourth**	**Pooled mean**
(2.01)	(2.05)	(2.00)	(2.05)	(2.03)
100.47	110.19	98.23	111.48	105.09
(2.00)	(2.03)	(1.99)	(2.04)	(2.02)
98.30	107.30	95.89	108.75	102.56
(1.32)	(1.36)	(1.36)	(1.41)	(1.36)
19.81	22.03	22.04	24.62	22.12
(1.26)	(1.34)	(1.36)	(1.40)	(1.34)
17.35	21.09	21.99	23.99	21.11
(1.67)	(1.68)	(1.68)	(1.75)	(1.69)
46.22	46.39	46.39	54.93	48.48
(1.65)	(1.67)	(1.68)	(1.74)	(1.69)
43.54	45.62	46.53	54.38	47.52
(1.62)	(1.66)	(1.66)	(1.74)	(1.67)
40.44	44.42	44.62	53.39	45.72
(1.91)	(1.92)	(1.88)	(1.94)	(1.91)
80.89	81.99	74.21	85.51	80.65
(2.08)	(2.11)	(2.08)	(2.15)	(2.11)
119.34	127.33	119.79	139.74	126.55
(2.08)	(2.11)	(2.09)	(2.15)	(2.11)
118.45	128.47	120.74	139.92	126.89
(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
0.00	0.00	0.00	0.00	0.00
(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
0.00	0.00	0.00	0.00	0.00
0.01	0.02	0.02	0.02	0.01
0.03	0.04	0.04	0.05	0.02

Figures in parenthesis are to log transformed

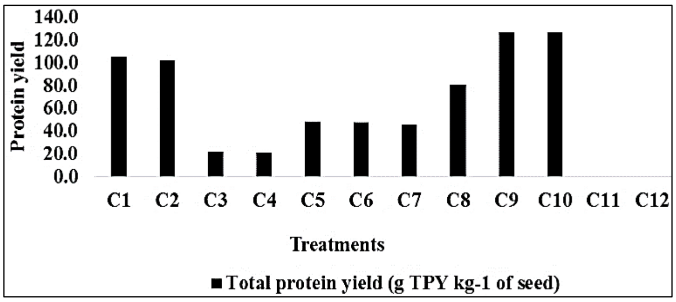

Fig 1: Effect of different crops on total protein yield under hydroponics

Crude fat content

Crude fat content was influenced significantly by different crops used in this study (Table 5). Among all the crops, higher crude fat content of7.24, 7.22, 7.25 and 7.23 per centwere registered ingrain cowpea (C_9) during first, second, third and fourth trial, respectively. It was on par with horse gram (C_{10})which recorded the crude fat content of7.25, 7.24, 7.23 and 7.21 per cent of crude fat on first, second, third and fourth trial, respectively, grain maize (C_2) which recorded the crude fat content of 7.20, 7.21, 7.21 and 7.20 per cent during first, second, third and fourth trial, respectively and fodder maize (C_1) with crude fat content of 7.21, 7.20, 7.20 and 7.21 per cent on first, second, third and fourth trial, respectively. However, among all the crops, soybean (C_{11}) and lucerne (C_{12}), registered the nil crude fat content in all the four trials.

Based on the pooled analysis also, crude fat content was higher in grain cowpea (C_9) with 7.24 per cent. It was on par with horse gram (C_{10}), grain maize (C_2) and fodder maize (C_1), which recorded the crude fat content of 7.23, 7.21 and 7.20 per cent, respectively. This is in line with the results of Snow *et al.*, 2008 [16].

Table 5: Effect of different crops on crude fat content (per cent) under hydroponics

Treatments Trial	Crude fat content				
	First	**Second**	**Third**	**Fourth**	**Pooled mean**
C_1-Fodder maize	(15.58)	(15.57)	(15.56)	(15.55)	(15.57)
	7.21	7.20	7.20	7.21	7.20
C_2-Grain maize	(15.55)	(15.57)	(15.57)	(15.56)	(15.56)
	7.20	7.21	7.21	7.20	7.21
C_3-Fodder bajra	(12.48)	(12.33)	(12.39)	(12.39)	(12.40)
	4.67	4.56	4.62	4.62	4.62
C_4-Grain bajra	(12.27)	(12.08)	(12.18)	(12.18)	(12.18)
	4.52	4.39	4.46	4.46	4.46
C_5-Barley	(14.04)	(14.09)	(14.07)	(14.06)	(14.07)
	5.89	5.93	5.91	5.91	5.91
C_6-Wheat	(14.29)	(14.34)	(14.31)	(14.32)	(14.31)
	6.09	6.13	6.11	6.11	6.11
C_7-Oat	(14.23)	(14.26)	(14.26)	(14.24)	(14.26)
	6.05	6.08	6.07	6.07	6.07
C_8-Fodder cowpea	(14.39)	(14.43)	(14.41)	(14.41)	(14.41)

	6.18	6.21	6.20	6.20	6.20
C_9-Grain cowpea	(15.60)	(15.59)	(15.61)	(15.58)	(15.61)
	7.24	7.22	7.25	7.23	7.24
C_{10}-Horse gram	(15.61)	(15.60)	(15.60)	(15.56)	(15.60)
	7.25	7.24	7.23	7.21	7.23
C_{11}-Soybean	(0.48)	(0.48)	(0.48)	(0.48)	(0.48)
	0.00	0.00	0.00	0.00	0.00
C_{12}-Lucerne	(0.48)	(0.48)	(0.48)	(0.48)	(0.48)
	0.00	0.00	0.00	0.00	0.00
SEd	0.33	0.38	0.36	0.51	0.22
CD (P=0.05)	0.69	0.78	0.75	1.06	0.46

Figures in parenthesis are Arcsine transformed

Crude fat yield

The crude fat yield was considerably varied due to different crops used under hydroponic fodder production system. It was calculated and presented in table 6 and represented in fig. 2. Among the crops under study, fodder maize (C_1) recorded maximum crude fat yield of 49.75, 53.68, 49.39 and 54.86 g crude fat kg^{-1} during first, second, third and fourth trial, respectively. It was on par with grain maize (C_2) having the crude fat yield of 48.78, 52.45, 48.35 and 53.59 g crude fat kg^{-1} of seeds during first, second, third and fourth trial, respectively, grain cowpea (C_9) with 49.15, 50.26, 46.79 and 54.20 g crude fat kg^{-1} of seeds and horse gram (C_{10}) having 48.82, 50.17, 46.78 and 53.77 g crude fat kg^{-1} of seeds during first, second, third and fourth trial, respectively. However, among all the crops, soybean (C_{11}) and Lucerne (C_{12}) registered the nil crude fat yield in all the four trials

Pooled analysis of crude fat yield from all the four trials also showed the similar trend as that of individual trials. In which, fodder maize (C_1), recorded significantly higher crude fat yield of 51.92 g crude fat kg^{-1} of seeds. It was on par with grain maize (C_2) having 50.79g, grain cowpea (C_9) having 50.10 g and horse gram (C_{10}) having 49.89g crude fat kg^{-1} of seeds. Similar experimental evidences for higher crude fat yield under hydroponics were also registered by Al-Karaki and Al-Hashimi (2011) [2].

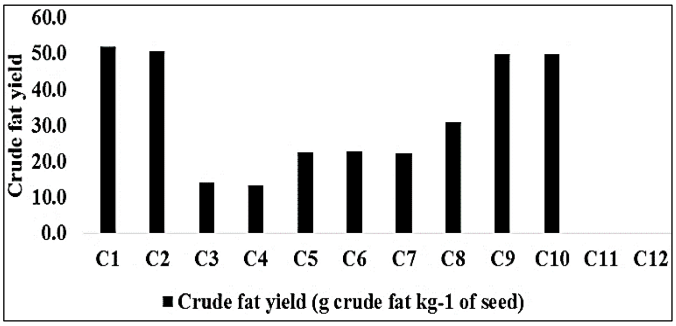

Fig 2: Effect of different crops on crude fat yield under hydroponics

Table 6: Effect of different crops on crude fat yield (g CFY kg^{-1} of seeds) under hydroponics

Crude fat yield				
First	**Second**	**Third**	**Fourth**	**Pooled mean**
(1.71)	(1.74)	(1.70)	(1.75)	(1.72)
49.75	53.68	49.39	54.86	51.92
(1.70)	(1.73)	(1.69)	(1.74)	(1.71)
48.78	52.45	48.35	53.59	50.79
(1.14)	(1.17)	(1.17)	(1.22)	(1.18)
12.90	13.93	13.86	15.52	14.05
(1.12)	(1.15)	(1.15)	(1.20)	(1.16)
12.12	13.27	13.26	14.80	13.36
(1.35)	(1.36)	(1.35)	(1.43)	(1.37)
21.13	21.85	21.49	25.85	22.58
(1.34)	(1.37)	(1.36)	(1.43)	(1.38)
20.75	22.27	22.07	26.00	22.77
(1.33)	(1.36)	(1.36)	(1.42)	(1.37)
20.17	22.05	21.74	25.54	22.37
(1.51)	(1.51)	(1.47)	(1.54)	(1.51)
31.01	31.60	28.47	33.38	31.12
(1.70)	(1.71)	(1.68)	(1.74)	(1.71)
49.15	50.26	46.79	54.20	50.10
(1.70)	(1.71)	(1.68)	(1.74)	(1.71)
48.82	50.17	46.78	53.77	49.89
(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
0.00	0.00	0.00	0.00	0.00
(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
0.00	0.00	0.00	0.00	0.00
0.02	0.02	0.02	0.03	0.01
0.05	0.04	0.05	0.06	0.02

Figures in parenthesis are to log transformer

Economics

The results (Table. 7) of the investigation clearly indicated that among the crops tested under hydroponic fodder production system, grain maize registered high net return of Rs. 1.22 kg^{-1} of seed and benefit cost ratio of 1.10 was found to be more suitable crop for economical green fodder production through hydroponics. The cost effectiveness of grain maize to produce green fodder under hydroponics was reported by Naik *et al.* (2015) [13].

Table 7: Effect of different crops on economics under hydroponics

Treatments			Cost of cultivation (Rs. kg^{-1} of seed)	Gross return (Rs. kg^{-1} of seed)	Net return (Rs. kg^{-1} of seed)	B:C ratio
C_1	-	Fodder maize	22.14	13.69	-8.45	0.62
C_2	-	Grain maize	12.14	13.36	1.22	1.10
C_3	-	Fodder bajra	37.14	6.82	-30.32	0.18
C_4	-	Grain bajra	32.14	6.72	-25.42	0.21
C_5	-	Barley	42.14	7.98	-34.16	0.19
C_6	-	Wheat	40.14	7.86	-32.28	0.20
C_7	-	Oat	52.14	7.79	-44.35	0.15
C_8	-	Fodder cowpea	72.14	10.50	-61.64	0.15
C_9	-	Grain cowpea	47.14	13.23	-33.92	0.28
C_{10}	-	Horse gram	44.14	13.11	-31.03	0.30
C_{11}	-	Soybean	82.14	0.00	-82.14	0.00
C_{12}	-	Lucerne	702.14	0.00	-702.14	0.00

Data not statistically analyzed

Conclusion

Based on the findings of this experiment, fodder maize, grain maize, grain cowpea and horse gram were identified as best performing crops under hydroponics for getting quality green fodder and nutritive value with relatively lesser cost.

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