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Influence of seed rate on growth, yield and economics of hydroponic fodder maize production

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Abstract
An investigation was conducted at AICRP for Dryland Agriculture, University of Agricultural Science, GKVK, Bengaluru to record the influence of seed rate on growth, yield and economics of hydroponic fodder maize production during 2017-18. Experiment was laid with completely randomized design having five replications with six seed rate treatments *viz.,* 1.50 (T_1), 1.75 (T_2), 2.00 (T_3), 2.25 (T_4), 2.50 (T_5) and 2.75 (T_6) kg m^{-2}. The study indicated that 2.50 kg m^{-2} seed rate had significantly higher shoot length (29.42 cm), root length (26.58 cm), total dry matter per kg seed (1600 g), green fodder yield per kg seed (4672 g) and green fodder yield (11.49 kg m^{-2}). But the quality attributes *viz.,* crude fibre, total carbohydrate and crude protein content of fodder maize were not influenced by seed rates. The higher growth and yield attributes led to higher net returns (Rs. 144 m^{-2}) and B:C ratio (2.00) under 2.50 kg m^{-2} seed rate as compared to other seed rates/treatments.

Keywords: Fodder maize, Green fodder yield, Growth attributes, Hydroponics, Seed rate

Introduction

Livestock is one of the fastest growing agricultural sub-sectors in developing countries. This growth has been driven by increasing demand for livestock products associated with population growth, urbanization and livelihood in developing countries (Delgado, 2005). In India, livestock plays an important role for nutritional and livelihood security of small and marginal farmers. The increased livestock population demands higher fodder in the country. But shortage of feed and fodder resources has been identified as one of the major constraints in achieving desired level of livestock productivity (Meena *et al.,* 2018). The scarcity of fodder and land allocation for cultivation of green fodder leads to reduced productivity in livestock. Further fodder production is adversely affected with climate change through erratic distribution of rainfall.

These problems can be overcome by hydroponics technology to produce green fodder for farm animals (Sneath and Mc Intosh, 2003; Naik *et al*., 2015). Hydroponics is an art and technology of growing crops without soil in the presence of water and proper nutrition that has revolutionized the green fodder production during 21st century. This process takes place in a very versatile and intensive growing unit where only water and nutrients are used to produce a fodder of shoot and root combination, which is very lush green and rich in nutrients.

Maize is an important cereal having diversified usage. Apart from grain consumption, it is also used as fodder due to its higher fresh biomass. Maize is a better choice for production of hydroponic fodder due to its availability, lower cost of seeds, higher biomass production, higher seed to biomass ratio and quicker growing habit (Naik *et al*., 2012). But hydroponic fodder production is a recent technology in India and demands standardization of agro-techniques scientifically. Optimum seed rate is the primary aspect in the agro-techniques, as the productivity, profitability and quality are associated with it. Hence, this investigation was conducted to record the influence of seed rate on growth, yield and economics of hydroponic fodder maize production.

Materials and Methods

Study area and hydroponic unit: Experiment was conducted at hydroponic facility of AICRP for Dryland Agriculture, University of Agricultural Sciences, GKVK, Bengaluru in two batches, the first batch was in the month of November 2017 and second batch during January 2018. The hydroponic unit was constructed with iron angles having a length of 325 cm, a width of 170 cm and a height of 220 cm. It was constructed to hold 30 trays and had three storeys of double rows and five columns. The iron angles were arranged at one side of the tray holder to align tray in a slanting position. Fodder growth unit consisted of 30 trays. Each tray was made with vinyl fibre of dimensions 2.5 × 1.5 × 0.15 ft. The unit consisted of lighting unit, humidifier and water spraying system with water tank of 100 liters capacity. The automated machine with pumping motor pumped the water from the tank and it was sprayed with drip laterals with foggers for each tray. The automation unit was set to spray water once every two hours for a minute.

Treatment details and analysis: Experiment was laid out in completely randomized design (CRD) with five replications having six seed rate treatments *viz.,* 1.50 (T_1), 1.75 (T_2), 2.00 (T_3), 2.25 (T_4), 2.50 (T_5) and 2.75 (T_6) kg m^{-2}. The seeds were soaked for 24 hours in the water and incubated for 48 hours in cotton cloth for germination. The sprouted seeds were kept on trays at a seed rate as per the treatment (dry seed weight) and allowed to grow for 14 days. The automated foggers were set to spray water for one minute in every two hours. Fodder maize was harvested on 14^{th} day from each treatment and converted into kilograms per square meter basis. The data pertaining to growth parameters *viz.,* shoot length, root length, seedling vigour, dry matter accumulation were recorded with five plants taken randomly from each treatments at 5 days after sowing (DAS), 10 DAS and at harvest. Seedling vigour was calculated as per the below given formula (Abdul Baki and Anderson, 1973).

Seedling vigour index = Germination (%) × Seedling length (cm)

Yield attributes were recorded in harvest samples. The randomly selected samples were dried in shade and then in oven at a temperature of 60 ^{0}C till constant weight. The green fodder maize yield was then converted into dry matter yield (kg m^{-2}). Dried samples were also ground to pass through 1mm sieve using electrically operated grinding mill and stored for analysis of quality attributes viz., crude protein, crude fibre and total carbohydrates following the standard method of AOAC (2000). Finally, the experimental data was analysed using Fisher's method of analysis of variance (ANOVA) as given by Gomez and Gomez (1984).

Results and Discussion

Growth attributes of fodder maize

Shoot length: The significant difference was noticed among different seed rates with respect to shoot length at all crop growth stages. Significantly higher shoot length at harvest was observed at 2.50 kg m^{-2} seed rate (29.42 cm) and it was at par with 2.25 kg m^{-2} (28.82 cm) and 2.00 kg m^{-2} (27.44 kg m^{-2}). The shorter shoots were recorded at 1.50 kg m^{-2} (26.82 cm) seed rate (Table 1). Light transmittance clearly declined with increased planting density from 1.50 kg m^{-2} to 2.75 kg m^{-2}. As density increased, plant height and first internode length increased but stem diameter reduced significantly. Thus, at higher density, intraspecific competition decreased the amount of light available for coexisting plants, which resulted in taller and thinner seedlings. At lower density more amounts of light and space available for individual plant might decrease the shoot length. The lower shoot length was noticed with lower seed rate due to reduced inter plant competition. The shoot length increased upto seed rate of 2.50 kg m^{-2} and thereafter it decreased due to overcrowding of seedlings leading to development of molds which in turn reduced growth of shoot. El-Morsy *et al*. (2013) was also observed increase in shoot length with higher seed density in barley.

Root length: At harvest, significantly higher root length was recorded with 2.50 kg m^{-2} seed rate (26.58 cm) as compared to 1.50 kg m^{-2} seed rate (24.15 cm) and it was at par with 2.25 kg m^{-2} (26.29 cm). The root length increased gradually upto 2.50 kg m^{-2} seed rate, thereafter reduced due to increased infestation of fungus in root mat which hindered the root proliferation. The root growth during initial stage was higher than that of shoot length, but as the growth advanced root growth was lesser than shoot. El-Morsy *et al*. (2013) recorded increase in root length with increased seed rate.

Seedling vigour: The seedling vigour at harvest was significantly higher with 2.50 kg m^{-2} seed rate (5218) as compared to 2.75 kg m^{-2} (4721) and it was at par with 2.25 kg m^{-2} (5128). As the seedling vigour is directly related with shoot length and root length of the crop, increased seedling length increased the seedling vigour and vice versa.

Yield and yield attributes of fodder maize

Green fodder yield per m^2: The green fodder yield of hydroponically grown fodder maize was influenced significantly by different seed rates. Seed rate of 2.50 kg m^{-2} recorded significantly higher green fodder yield (11.49 kg m^{-2}) as compared to 1.50 kg m^{-2} (6.01 kg m^{-2}). However, it was at par with 2.75 kg m^{-2} (11.81 kg m^{-2}). Seed rate with 2.50 kg m^{-2} recorded 47.69 per cent higher

Table 1. Growth attributes of fodder maize as influenced by seed rate under hydroponics

Treatment	Shoot length (cm)			Root length (cm)			Seedling vigour		
	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled
T_1	25.20	28.43	26.82	23.93	24.37	24.15	4577	4912	4744
T_2	26.32	28.09	27.21	24.24	24.50	24.37	4695	4889	4792
T_3	26.34	28.54	27.44	24.57	24.00	24.28	4721	4883	4802
T_4	26.92	30.71	28.82	25.98	26.61	26.29	4922	5334	5128
T_5	27.98	30.86	29.42	26.48	26.69	26.58	5077	5359	5218
T_6	25.04	29.19	27.12	24.34	24.00	24.17	4545	4897	4721
SEM	0.48	0.58	0.53	0.46	0.58	0.53	56.33	78.80	68.49
CD (P<0.01)	1.91	2.30	2.03	1.83	2.31	1.99	222.80	311.69	259.80

Table 2. Green fodder yield as influenced by seed rate under hydroponics

Treatment	Yield (kg m^{-2})			Yield per kg seeds (kg)		
	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled
T_1	5.93	6.08	6.01	3.95	4.05	4.00
T_2	6.43	7.67	7.05	3.68	4.38	4.03
T_3	7.83	8.97	8.40	3.92	4.48	4.20
T_4	8.95	10.92	9.94	3.98	4.85	4.42
T_5	11.06	11.93	11.49	4.42	4.77	4.60
T_6	11.58	12.04	11.81	4.21	4.38	4.30
SEM	0.23	0.23	0.23	0.11	0.12	0.12
CD (P<0.01)	0.92	0.91	0.88	0.43	0.48	0.44

T_1: 1.50 kg m^{-2}; T_2: 1.75 kg m^{-2}; T_3: 2.00 kg m^{-2}; T_4: 2.25 kg m^{-2}; T_5: 2.50 kg m^{-2}; T_6: 2.75 kg m^{-2}

fodder yield than 1.50 kg m^{-2} (Table 2). Increased seed rate increased the green fodder yield significantly due to increased number of plant population. The higher dry matter accumulation at different growth stages resulted in higher fresh fodder yield.

Green fodder yield per kg seed: The green fodder yield per kg of seed was significantly higher at a seed rate of 2.50 kg m^{-2} (4.60 kg kg^{-1} seed) as compared to 1.50 kg m^{-2} (4.00 kg kg^{-1} seed). However, it was at par with 2.25 kg m^{-2} (4.42 kg kg^{-1} seed), 2.75 kg m^{-2} (4.30 kg kg^{-1} seed) and 2.00 kg m^{-2} (4.20 kg kg^{-1} seed) (Table 2). Seed rate of 2.50 kg m^{-2} recorded 13.04 per cent higher green fodder yield per kg seeds than seed rate of 1.50 kg m^{-2}. The green fodder yield of the maize per kg seed sown increased upto 2.50 kg m^{-2} thereafter it decreased, which might be due to increased seed density leading to increase in intra plant competition for space, light and water. The increased seed density might have further increased temperature of the microclimate owing to higher plant respiration and leading to lower accumulation of dry matter. Moreover, increased seed rate led to more microbial growth in root mat which might affect the growth of individual plants. Naik *et al*. (2017) also reported increase in fresh yield of the maize grown hydroponically with increased seed rate up to some extent, thereafter it was reduced drastically.

Fresh weight of different parts of fodder maize

Fresh weight of fodder maize per m^2: The total green fodder yield was resultant of the dry matter accumulation of different parts of plant during different growth stages. Significantly higher fresh weight of shoot, root and total was recorded at 2.50 kg m^{-2} seed rate (6075, 2758 and 11679 g m^{-2}, respectively) as compared to 1.50 kg m^{-2} (3358, 1423 and 6078 g m^{-2}, respectively), however it was at par with 2.75 kg m^{-2} (6130, 2967 and 11975 g m^{-2}, respectively). Seed rate of 2.50 kg m^{-2} recorded 47.95% higher total fresh yield as compared to 1.50 kg m^{-2} (Table 3). The higher fresh weight of the fodder was recorded at higher seed rate might be due to higher plant population. The increased plant population led to increase in shoot, root, cotyledon and total fresh weights at the time of harvest. This was in conformity with the earlier observations of Naik *et al.* (2017).

Increased seed rate increased competition for resources like water, space and light among the plants. The availability of space, light and water were identical, hence the plants with less seed rate got plenty of resources and put forth vigorous growth but as the seed rate increased the growth of seedlings reduced and led to lower fresh weight per individual plants. The significantly higher fresh weights of shoot and root of individual plant were recorded at 1.50 kg m^{-2} seed rate (56.52 and 22.71%,

Table 3. Fresh weight of plants (g m^{-2}) of fodder maize as influenced by seed rate under hydroponics

Treatment	Shoot			Root			Cotyledon			Total		
	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled
T_1	3419	3297	3358	1271	1574	1423	1260	1334	1297	5950	6205	6078
T_2	3843	4002	3922	1620	1836	1728	1695	1795	1745	7158	7633	7395
T_3	4694	4624	4659	1995	2146	2070	2011	2094	2052	8699	8863	8781
T_4	5061	5626	5344	2262	2312	2287	2461	2544	2502	9783	10483	10133
T_5	5806	6344	6075	2664	2852	2758	2742	2951	2846	11212	12147	11679
T_6	5941	6319	6130	2885	3048	2967	2919	2839	2879	11745	12206	11975
SEM	227.10	170.40	200.76	44.84	62.90	54.62	90.59	87.43	89.02	245.33	202.55	224.96
CD (P<0.01)	898.29	674.02	761.54	177.36	248.82	207.20	358.31	345.83	337.68	970.41	801.20	853.33

Table 4. Fresh weight per kg seed (g) of fodder maize as influenced by seed rate under hydroponics

Treatment	Shoot			Root			Cotyledon			Total		
	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled
T_1	2279	2198	2239	847	1050	949	840	889	865	3967	4137	4052
T_2	2196	2287	2241	926	1049	987	969	1026	997	4090	4362	4226
T_3	2347	2312	2329	997	1073	1035	1005	1047	1026	4350	4432	4391
T_4	2249	2501	2375	1005	1028	1016	1094	1131	1112	4348	4659	4503
T_5	2322	2538	2430	1065	1141	1103	1097	1180	1139	4485	4859	4672
T_6	2160	2298	2229	1049	1108	1079	1061	1032	1047	4271	4438	4355
SEM	113.77	83.20	99.66	21.03	34.99	28.87	42.62	42.93	42.78	122.11	103.57	113.22
CD (P<0.01)	NS	NS	NS	83.20	NS	109.50	168.58	169.81	162.26	NS	409.66	429.46

T_1: 1.50 kg m^{-2}; T_2: 1.75 kg m^{-2}; T_3: 2.00 kg m^{-2}; T_4: 2.25 kg m^{-2}; T_5: 2.50 kg m^{-2}; T_6: 2.75 kg m^{-2}

respectively) as compared to 2.75 kg m^{-2} (52.05 and 23.98 %, respectively) but, it was at par with all other treatments. Non-significant differences were obtained with respect to cotyledon fresh weight. The seed rate of 1.50 kg m^{-2} recorded 17.39 per cent higher total fresh weight per seedling as compared 2.75 kg m^{-2}. The higher individual fresh weight of seedling was mainly attributed to higher amount of dry matter partitioning to different parts of seedling at different stages of growth in every plant and it was noticed higher with lower seed rates.

Even though higher shoot, root, cotyledon and total fresh weights of individual seedlings was observed at 1.50 kg m^{-2} seed rate (Table 5), the total shoot, root, cotyledon and whole fresh weight yield at harvest was lower than other treatments due to lower plant population. The green fodder yield was higher at seed rate of 2.75 kg m^{-2} even under lower fresh weight of individual plant, mainly attributed to higher plant population. The lower seed rate might resulted in underutilization of available resources like space and water, which in turn resulted in lesser fodder production and returns per unit quantity of resources utilized during growth.

***Fresh weight of fodder maize per kg seeds*:** This parameter was also considered for evaluating the different seed rates. Higher fresh weight of shoot, root, cotyledon and total yield was obtained at the seed rate of 2.50 kg m^{-2} (2430, 1103, 1139 and 4672 g kg^{-1} seed, respectively) and lower total fresh yield per kg of seeds was obtained at 1.50 kg m^{-2} (2239, 949, 865 and 4052 g kg^{-1} seed, respectively). The seed rate of 2.50 kg m^{-2} recorded 13.72 per cent higher fresh yield per kg of seeds than 1.50 kg m^{-2} (Table 4). Here the higher fresh yield in different parts of the plant at 2.50 kg m^{-2} seed rate was mainly due to higher dry matter accumulation per kg seeds in different parts of the plant at harvest (Table 5). The dry matter accumulation increased due to higher growth attributes like shoot length, root length and seedling vigour. The increase in growth attributes were mainly due to increased cell division and cell elongation, which might led to higher photosynthates accumulation and thereby increasing the absolute growth rate of the seedlings during different growth stages.

The fresh weight of shoot, root and cotyledon per kg seeds sown increased with increased seed rate upto 2.5 kg m^{-2} and thereafter it decreased with 2.75 kg m^{-2}. The reduction in yield was associated with reduced accumulation of photosynthates in shoot and root caused by increased inter plant competition between seedlings, which might have reduced shoot length, root length and seedling vigour and finally resulted in lower fresh yield per kg seeds. This was also in conformity with the observations of Naik *et al.* (2017).

Dry matter accumulation and its distribution

***Dry matter accumulation per m²*:** The dry matter accumulation at different growth stages in different parts of the seedlings *viz.,* shoot, root, cotyledon were varied significantly among the treatments. Significantly higher dry matter accumulation in shoot, root, cotyledon and total was observed at seed rate of 2.75 kg m^{-2} (1560, 734, 1904 and 4198 g m^{-2}, respectively) and 2.50 kg m^{-2} (1547, 684, 1769 and 4000 g m^{-2}, respectively) as compared to 1.50 kg m^{-2} (732, 346, 728 and 1806 g m^{-2}, respectively). The total dry matter accumulation at 2.50 kg m^{-2} was 54.85 per cent higher as compared to 1.50 kg m^{-2} and only 4.71 per cent lower than 2.75 kg m^{-2} (Table 6). The higher total dry matter accumulation in different parts with 2.50 kg m^{-2} seed rate was mainly attributed to higher growth rate during different stages as compared to 1.50 kg m^{-2} seed rate. Even though the dry matter accumulation was lower in individual plants, the higher plant population might lead to higher total dry matter yield of the crop at a seed rate of 2.50 kg m^{-2}. The lower dry matter accumulation in 1.50 kg m^{-2} was probably due to reduced growth attributes like shoot length, root length and seedling vigour.

Table 5. Fresh weight of individual plant (%) of fodder maize as influenced by seed rate under hydroponics

Treatment	Shoot			Root			Cotelydon		
	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled
T_1	56.31	56.46	56.52	21.84	23.44	22.71	21.84	20.10	20.77
T_2	53.77	54.95	54.50	22.61	22.77	22.50	23.62	22.28	23.00
T_3	55.15	54.12	54.64	22.16	22.16	22.16	22.68	23.71	23.20
T_4	51.87	54.82	53.65	22.46	21.32	21.88	25.13	23.35	24.48
T_5	51.63	53.89	52.91	22.83	21.76	22.22	25.54	24.35	24.87
T_6	50.89	52.87	52.05	24.26	23.56	23.98	24.85	23.56	24.56
SEM	0.84	0.52	0.70	0.39	0.47	0.43	1.00	0.85	0.98
CD (P<0.01)	3.32	2.04	2.64	1.53	1.84	1.63	NS	NS	NS

Table 6. Dry matter accumulation (g m^{-2}) in different parts of fodder maize as influenced by seed rate under hydroponics

Treatment	Shoot			Root			Cotyledon			Total		
	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled
T_1	733	731	732	346	346	346	730	727	728	1809	1803	1806
T_2	858	875	866	403	374	389	923	923	923	2184	2173	2178
T_3	913	955	934	445	431	438	1075	1041	1058	2432	2427	2430
T_4	1181	1219	1200	557	562	559	1411	1387	1399	3149	3168	3158
T_5	1555	1539	1547	690	678	684	1767	1770	1769	4012	3987	4000
T_6	1552	1568	1560	729	739	734	1891	1917	1904	4173	4224	4198
SEM	39.67	35.30	37.55	15.88	16.28	16.08	33.61	30.16	31.93	59.89	48.76	54.61
CD (P<0.01)	156.91	139.61	142.42	62.81	64.39	61.00	132.94	119.29	121.12	236.90	192.86	207.14

Table 7. Dry matter accumulation per kg seeds (g) of fodder maize as influenced by seed rate under hydroponics

Treatment	Shoot			Root			Cotyledon			Total		
	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled
T_1	489	487	488	231	231	231	486	485	486	1206	1202	1204
T_2	490	500	495	230	214	222	528	528	528	1248	1242	1245
T_3	456	477	467	223	215	219	537	521	529	1216	1213	1215
T_4	525	542	533	247	250	249	627	617	622	1399	1408	1404
T_5	622	616	619	276	271	274	707	708	707	1605	1595	1600
T_6	564	570	567	265	269	267	688	697	692	1517	1536	1527
SEM	17.99	16.15	17.10	7.68	6.77	7.24	13.89	12.37	13.15	24.99	21.09	23.13
CD (P<0.01)	71.16	63.89	64.85	30.39	26.78	27.47	54.96	48.91	49.89	98.85	83.44	87.72

Dry matter accumulation per kg seeds: Significantly higher dry matter accumulation per kg seeds was observed in shoot, root, cotyledon and their total at a seed rate of 2.50 kg m^{-2} (619, 274, 707 and 1600 g kg^{-1} seed, respectively) as compared to 1.50 kg m^{-2} (488, 231, 486 and 1204 g kg^{-1} seed, respectively). The seed rate with 2.50 kg m^{-2} showed 4.56 per cent higher dry matter accumulation than 2.75 kg m^{-2} (Table 7). This was markedly influenced by higher growth attributes like shoot length, root length and seedling vigour due to optimum availability of resources for growth and development. Increased growth and development of shoot and root at different stages of growth resulted in higher photosynthetic activity and better translocation of photosynthates to different parts, which ultimately led to higher dry matter accumulation at harvesting stage. The dry matter accumulation per kg seeds increased with increased seed rate up to 2.50 kg m^{-2} thereafter, it was reduced at 2.75 kg m^{-2}. It was mainly due to competition between seedlings for growth resources *viz.,* space, light and water *etc*. Further, higher seed rate than optimum also encouraged the growth of fungus and hindered the accumulation of dry matter. These findings were in agreement with Islam *et al.* (2016).

Quality attributes

The quality attributes *viz.,* crude fibre, total carbohydrate and crude protein content of fodder maize were not influenced by seed rate (Table 8). During initial stages of growth the crop utilized the food stored in the seed for initiation of plumule and radicle that became shoot and root, since there were no external nutrient supplement during the growth stages of fodder maize and thus no changes were observed in the quality parameters. Naik *et al.* (2017) also observed non-significant differences in quality attributes of hydroponically grown fodder maize under different seed rates.

Economics

Among different treatments, seed rate with 2.50 kg m^{-2} recorded higher net returns (Rs. 144 m^{-2}) and B:C ratio (2.00), but gross return was higher with 2.75 kg m^{-2} (Rs. 295 m^{-2}). The increased seed rate increased the total fodder yield of maize that in turn increased gross return, net return and B:C ratio. The B:C ratio of treatments increased upto 2.50 kg m^{-2} and thereafter decreased due to increased seed rate. Higher growth and yield attributes helped to achieve higher fodder yield which finally resulted in higher net return compared to other treatments. The lower gross return (Rs. 150 m^{-2}), net return (Rs. 47 m^{-2}) and B:C ratio (1.45) was observed at a seed rate of 1.50 kg m^{-2} due to lower fodder yield (Table 9). These results were in agreement with Naik *et al.* (2017).

Table 8. Quality attributes of fodder maize at harvest under hydroponics

Treatment	Crude protein (%)			Crude fibre (%)			Total carbohydrates (%)		
	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled
T_1	12.91	12.72	12.81	11.67	11.45	11.56	61.46	60.39	60.93
T_2	12.88	12.85	12.86	11.89	11.89	11.89	59.70	61.88	60.79
T_3	12.37	12.74	12.55	11.58	11.02	11.30	59.97	61.03	60.50
T_4	12.99	12.83	12.91	11.95	11.71	11.83	60.18	60.77	60.47
T_5	13.57	13.33	13.45	11.93	12.16	12.05	60.87	61.41	61.14
T_6	12.34	12.63	12.48	11.12	10.52	10.82	60.55	60.95	60.75
SEM	0.26	0.38	0.32	0.35	0.45	0.40	1.60	1.40	1.50
CD (P<0.01)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 9. Economics of fodder maize as influenced by seed rate under hydroponics

Treatment	Cost of cultivation (Rs. m^{-2})	Gross return (Rs. m^{-2})	Net return (Rs. m^{-2})	B:C ratio
T_1	103	150	47	1.45
T_2	114	176	63	1.55
T_3	124	210	86	1.69
T_4	134	249	114	1.85
T_5	145	289	144	2.00
T_6	155	295	140	1.91

T_1: 1.50 kg m^{-2}; T_2: 1.75 kg m^{-2}; T_3: 2.00 kg m^{-2}; T_4: 2.25 kg m^{-2}; T_5: 2.50 kg m^{-2}; T_6: 2.75 kg m^{-2}

Conclusion

It was observed that the seed rate of 2.50 kg m^{-2} was optimum for better growth, higher green fodder yield (11.49 kg m^{-2}) and B:C ratio (2.00) in fodder maize. Hence, it was concluded that seed rate of 2.50 kg m^{-2} can be recommended for the production of hydroponics maize fodder for optimal green fodder yield.

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