Indian Journal of Animal Sciences **87** (1): 109–112, January 2017/Article

Effect of seed rate on yield and proximate constituents of different parts of hydroponics maize fodder

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Received: 19 December 2015; Accepted: 20 June 2016

ABSTRACT

A study was conducted to find out the effect of seed rate (3.8, 5.1, 6.4, 7.6, 8.9 and 10.2 kg/m^2) on the yield and proximate constituents of different parts of the hydroponics maize fodder (HMF) produced in a hydroponics chamber (greenhouse) measuring about 25 ft length × 10 ft width × 10 ft height with a daily production potential of 600 kg fresh HMF; and equipped with automatic sprayer irrigation of tap water. The HMF looked like a mat of 20–30 cm height consisting of roots along with germinated seeds and leaves. The total yields (kg) of the HMF both on fresh basis (4.94–4.97) and DM basis (0.67–0.64) were similar and higher with a seed rate of 3.8 to 7.6 kg/m^2. The yield (kg, as % of total yield) of the leaves on fresh basis (1.67–1.60, 31.59–32.49) and DM basis (0.11, 16.33–16.99) was similar and higher with a seed rate of 5.1 to 7.6 kg/m^2. The fresh yield (kg) of the roots along with the germinated seeds increased with the increase in the seed rate. The yield (as % of total yield) of the roots with the germinated seeds on fresh basis remained similar up to seed rate of 8.9 kg/m^2 (67.51–69.26) and increased at the seed rate of 10.2 kg/m^2 (72.57). The seed rate had no effect on the proximate constituents of different portions *i.e.* roots with germinated seeds, leaves and plants of HMF. However, irrespective of the seed rate, there was difference in the proximate constituents of roots with germinated seeds, leaves and plants of HMF. The HMF had highest moisture content in the roots (15.68%) and lowest in the leaves (6.81%). The CP, CF and TA contents (%) of the HMF were highest in the leaves (22.15, 17.69 and 3.84) and lowest in the roots (10.25, 9.76 and 1.59). The EE content of the leaves (2.90%) was similar with the roots (3.01%) and plants (2.29%), however, the roots and plants were different. It can be concluded that the seed rate had no effect on the proximate constituents of different portions i.e. roots with germinated seeds, leaves and plants of the HMF. The seed rate of 7.6 kg/m^2 can be recommended for the production of hydroponics maize fodder for optimal output and all parts of the hydroponics maize fodder are nutritious.

Key words: Fodder, Hydroponics, Maize, Nutrient, Production, Seed, Yield

Hydroponics technology is coming up to grow fodder for the dairy animals as an alternative to conventional method of fodder cultivation due to various constraints in the later (Naik and Singh 2014, Naik *et al*. 2015). The seed rate, i.e. the quantity of seeds loaded per unit surface area of the greenhouse tray affects the germination of the seeds. If the seed density is high, there are more chances of microbial contamination in the root mat of the plants, which affects the growth of the hydroponics fodder. Further, as the hydroponics fodder consists of roots along with germinated seeds and leaves, the nutrient content of the various portions may differ. However, only a few reports are available on the yield and nutrient content of hydroponics fodder in India (Reddy *et al*. 1988, Naik *et al*. 2015). Therefore, an experiment was conducted to find out the effect of seed rate on the yield and proximate constituents of different portions of hydroponics maize fodder.

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MATERIALS AND METHODS

Hydroponics maize fodder (HMF) was produced in a hydroponics chamber (greenhouse) measuring about 25 ft length × 10 ft width × 10 ft height with a daily production potential of 600 kg fresh HMF; and equipped with automatic sprayer irrigation of tap water. Clean seeds of maize (*Zea mays* L.) with seed rate of 3.8, 5.1, 6.4, 7.6, 8.9 and 10.2 kg/m^2 with replicates of eight for each level of seed rate were soaked in tap water individually for 4 h. The seeds were strained and put on the greenhouse trays. Inside the greenhouse, they were allowed to grow for 7 days and on 8th day, these were harvested. After harvesting the hydroponics maize fodder daily, the roots along with germinated seeds and leaves were separated manually for proximate analysis (AOAC 2000). The experiment was

conducted for a period of 30 days. The data were analyzed statistically for the test of significance (Snedecor and Cochran 1994).

RESULTS AND DISCUSSION

The total yields (kg) of the HMF both on fresh basis (4.94–4.97) and DM basis (0.67–0.64) were similar and higher with a seed rate of 3.8 to 7.6 kg/m^2 (Table 1). More leaves in HMF are desirable. Yield of leaves (kg as % of total yield) on fresh basis (1.67–1.60, 31.59–32.49) and DM basis (0.11, 16.33–16.99) was similar and higher with a seed rate of 5.1 to 7.6 kg/m^2. More roots in the HMF are not desirable as it enhances more mould growth. The fresh yield (kg) of the roots along with the germinated seeds increased with the increase in the seed rate. The yield (as % of total yield) of the roots with germinated seeds on fresh basis remained similar up to seed rate of 8.9 kg/m^2 (67.51–69.26) and increased at the seed rate of 10.2 kg/m^2 (72.57). Most of the commercial units recommended seeding rates of 6–8 kg/m^2 (Morgan *et al.* 1992), however, the total dry weight increases with the increase of seeding rate up to 5 kg/m^2, thereafter, there is significant depression, therefore seeding rate of 4 kg/m^2 is the most efficient for seedling growth (Massantini and Magnani 1980). Dung *et al.* (2010) and Fazaeli *et al.* (2011) distributed the seeds in the trays with a seed rate density of 6.7 kg/m^2 and 4.5 kg/m^2 for growing hydroponics barley fodder. Yields up to 8 folds and DM up to 15% are common in commercial advertisements; while trial yields ranged from 5–8 folds

Table 1. Yield of hydroponics maize fodder at various seed rate

Attribute	Seed rate (kg/m^2)*					
	3.8	5.1	6.4	7.6	8.9	10.2
			Fresh yield/kg seed			
Total yield (kg)	4.94^{b}	5.14^{b}	5.02^{b}	5.07^{b}	4.97^{b}	4.72^{a}
Leaves yield (kg)	1.55^{b}	1.67^{c}	1.59^{bc}	1.60^{bc}	1.53^{b}	1.29^{a}
Root yield (kg)	2.55^{a}	3.48^{b}	4.29^{c}	5.19^{d}	6.02^{e}	6.86^{f}
Leaves (% of total yield)	31.42^{b}	32.49^{b}	31.59^{b}	31.69^{b}	30.74^{b}	27.43^{a}
Roots (% of total yield)	68.58^{a}	67.51^{a}	68.41^{a}	68.32^{a}	69.26^{a}	72.57^{b}
			DM yield/kg seed			
Total yield (kg)	0.67^{c}	0.68^{c}	0.66^{c}	0.64^{bc}	0.60^{b}	0.54^{a}
Leaves yield (kg)	0.11^{b}	0.11^{b}	0.11^{b}	0.11^{b}	0.11^{b}	0.09^{a}
Root yield (kg)	0.56^{bc}	0.57^{c}	0.54^{ab}	0.54^{ab}	0.53^{a}	0.52^{a}
Leaves (% of total yield)	15.74^{a}	16.72^{ab}	16.33^{ab}	16.99^{ab}	17.38^{b}	16.83^{a}
Roots (% of total yield)	83.98	83.29	83.67	83.01	82.62	83.17

*P<0.05; Values bearing different superscript in a row differ significantly.

Table 2. Proximate constituents of different portions of hydroponics maize fodder at various seed rate

Attribute	Seed rate (kg/m^2)*					
	3.8	5.1	6.4	7.6	8.9	10.2
			Roots with germinated seeds			
Moisture	14.77	15.23	15.43	15.53	16.40	16.73
CP	10.29	10.29	10.30	10.30	10.17	10.15
EE	3.00	2.98	2.97	3.09	3.08	2.96
CF	9.79	9.70	9.78	9.72	9.90	9.65
NFE	75.37	75.48	75.37	75.30	75.22	75.61
TA	1.55	1.55	1.58	1.59	1.63	1.63
AIA	0.29	0.29	0.35	0.35	0.36	0.37
			Leaves			
Moisture	6.83	6.77	6.77	6.73	6.83	6.93
CP	22.27	22.22	22.24	22.73	21.70	21.76
EE	2.90	2.88	2.86	2.90	2.92	2.92
CF	17.41	17.85	17.81	17.71	17.65	17.70
NFE	53.57	53.26	53.25	52.82	53.88	53.77
TA	3.84	3.79	3.85	3.84	3.85	3.85
AIA	0.57	0.56	0.56	0.58	0.58	0.58
			Plants			
Moisture	12.57	12.30	12.77	12.00	12.20	12.93
CP	12.39	12.38	12.41	12.41	12.53	12.17
EE	2.54	2.26	2.51	2.14	2.12	2.17
CF	12.88	12.82	12.91	12.83	12.88	12.90
NFE	70.14	70.50	70.14	70.55	70.42	70.72
TA	2.04	2.05	2.03	2.07	2.04	2.05
AIA	0.52	0.46	0.52	0.49	0.49	0.52

*Nonsignificant (P<0.05).

(Sneath and Mclntosh 2003). Fresh yield of 3.5–6.0 folds with DM content of 10.3–18.5% in 7–8 days was reported for hydroponics maize fodder (Naik *et al.* 2015).

The germination started on second and third day and the roots were clearly visible from third and fourth day onwards in hydroponics system. The HMF looked like a mat of 20–30 cm height consisting of roots along with germinated seeds and leaves (Naik *et al*. 2016a, Naik *et al*. 2016b). Depending upon the type of grain, the forage mat reaches 15–30 cm high (Mukhopad 1994). By the end of the germination period of 8-days, the wheat, barley and oat seedlings were approximately 11.0, 14.0 and 11.5 cm in height, respectively (Snow *et al.* 2008).

The seed rate had no effect (P>0.05) on the proximate constituents of different portions i.e. roots with germinated seeds, leaves and plants of HMF (Table 2). However, irrespective of the seed rate, there was difference (P<0.05) in the proximate constituents of roots with germinated seeds, leaves and plants of HMF (Table 3). The moisture content was highest in the roots (15.68%) and lowest in the leaves (6.81%) of the HMF. The CP, CF and TA contents (%) were highest in the leaves (22.15, 17.69 and 3.84) and lowest in the roots (10.25, 9.76 and 1.59). The EE content of the leaves (2.90%) was similar with the roots (3.01%) and plants (2.29%), however, the roots and plants were different (P<0.05). In earlier studies (Naik *et al*. 2012, Naik *et al*. 2014) we reported 18.30% DM, 13.30–13.57% CP, 3.27–3.49% EE, 6.37–14.07% CF, 66.72–75.32% NFE, 1.75–3.84% TA and 0.33–0.57% AIA in the HMF, which is similar to the nutrient content of the HMF plant of the present study. The CP contents of the leaves and roots of the HMF were similar to the CP contents of the leguminous and non-leguminous green fodder, respectively (ICAR 1998, Naik *et al*. 2012, 2014). Reddy *et al.* (1988) also reported that the nutrient content of the barley sprouts were superior to certain common non-leguminous fodders, but comparable to leguminous fodders. In India, there are reports of increase in digestibility of nutrients and/or milk yield by feeding of HMF or hydroponically sprouted maize grains (Naik *et al*. 2014, 2016a, b).

Table 3. Proximate constituents of different portions of hydroponics maize fodder irrespective of seed rate

Attribute	Hydroponics maize fodder*		
	Roots with germinated seeds	Leaves	Plants
Moisture	15.68^{c}	6.81^{a}	12.46^{b}
CP	10.25^{a}	22.15^{c}	12.38^{b}
EE	3.01^{b}	2.90^{ab}	2.29^{a}
CF	9.76^{a}	17.69^{c}	12.87^{b}
NFE	75.40^{c}	53.42^{a}	70.40^{b}
TA	1.59^{a}	3.84^{c}	2.05^{b}
AIA	0.34^{a}	0.57^{b}	0.50^{b}

*Means bearing different superscripts in a row differ significantly (P<0.05).

It can be concluded that the seed rate had no effect on the proximate constituents of different portions i.e. roots with germinated seeds, leaves and plants of the HMF. The seed rate of 7.6 kg/m^2 can be recommended for the production of hydroponics maize fodder for optimal output and all parts of the hydroponics maize fodder are nutritious.

ACKNOWLEDGEMENT

The authors are thankful to Indian Council of Agricultural Research (ICAR), New Delhi; Rashtriya Krishi Vikas Yojana (RKVY), Govt. of India and Goa Dairy, Curti, Ponda, Goa for providing financial support to conduct the study.

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