Evaluation of low-cost hydroponics using different crops as a supplementation for fodder production for livestock

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ABSTRACT

The present study on evaluation of low-cost hydroponics using different crops as a supplementation for fodder for livestock was conducted at Kumaraguru Institute of Agriculture, Tamil Nadu in 2019. From the study, it was concluded that on 8th day, shoot biomass per plant was recorded maximum in maize (55 g) and minimum in ragi (37 g). Highest fodder production was recorded in maize (8.6 kg). Maize also resulted in highest B-C ratio of 1:2.8. The results showed that maize was superior over other crops in case of shoot biomass per plant production, fodder production and B-C ratio.

Keywords: Hydroponics; fodder production; crops; livestock

INTRODUCTION

Green fodder feeding to livestock ensures optimization of productivity. Though India is the top producer of milk in the world, insufficient livestock feed and fodder is one of the constraints affecting growth, health, production and reproduction potential of livestock. In India only 4.9 per cent of cropped land area is utilized for cultivating fodder. India faces a deficit of 35.6 per cent green fodder, 26 per cent of dry fodder and 41 per cent of concentrate feed ingredients (Jagdale et al 2018).

In Tamil Nadu, 30.7 million heads of livestock are reared, which depend on 0.17 million ha of cultivable fodder area and 0.11 million ha of pasture land. The pasture land has declined over the past. However, fodder production is gaining momentum through various schemes of Government of Tamil Nadu and this has reduced the deficit of green fodder to 25 per cent (Jemimah et al 2015).

A novel method called 'Hydroponics' means growing plants without soil by using nutrient water at desired temperature and humidity. Through hydroponics, it is easier and quick to produce nutritive green fodder. It is a simple rural-friendly low-cost hydroponic device to produce 15-30 kg of fodder daily targeting resource poor rural farmers, who rear one or two milch animals. Hydroponics may be the farmers' choice of fodder production in future (Jemimah et al 2015).

The crops like maize (Naik et al 2011, Naik et al 2012, Ningoji 2020), barley (Reddy et al 1988), oats, cowpea, horse gram, ragi, sun hemp, bajra, jowar, moth bean, foxtail millet, sanwa millet, kodo millet and little millet can be grown successfully under hydroponic fodder production system.

However, geographical and agro-climatic conditions and easy availability of seeds are the choice for hydroponics technology. In India, easy availability of seed, lower seed cost, good biomass production and quick growing habit, maize is the choice of grain for hydroponics fodder production (Singh 2020). Leguminous crops grow well under hydroponics which is encouraging as fodder has high crude protein content than cereal crops (Jemimah et al 2015). In the present study, experiment was conducted to evaluate the growth and yield parameters and economics of different crops through hydroponics.

MATERIAL and METHODS

The experiment was conducted at Kumaraguru Institute of Agriculture, Erode, Tamil Nadu to examine the growth parameters of different crops using hydroponics during Feb-March and April-May 2019.

The experimental farm was situated in western agro-climatic zone of Tamil Nadu at 11°49' N latitude, 77°56' E longitude at an altitude of 200 m amsl. The average minimum and maximum temperature in the area ranged from 32 to 34°C and relative humidity from 65 to 80 per cent during the cropping period.

The experiment was laid out in completely randomized block design with three replications. The low-cost hydroponics system was made by using locally available PVC pipe which was modified with the size of 20 m × 10 m in a shade net.

The experiment was laid out as per Jemimah et al (2015). The seeds of crops were soaked in water for 20 h which sprouted in 24 h. Trays were racked in the stand and fully grown fodder was ready on 8th day (Plates 1-8).

Seed storage and preparation: The seeds were dried under direct sunlight one day prior to seed washing. Broken seeds and dirt from seeds were removed and seeds were stored in a dry and safe place.

Seed washing: Good quality seeds were taken in a washing chamber to which water was added. Seeds were washed properly scrubbing by hands and kept for settling for 5 min. Light weight floating seeds were removed. The water was drained out and more water was added again. These were stirred manually by wooden stick for 5 minutes and kept for settling for 5 min. Water was drained out. These steps were repeated till the dirt and dead seeds were removed.

Seed soaking: Stimulant solution was prepared in the soaking chamber. The seeds were added to the soaking chamber; lid was closed and kept for soaking for a number of hours after which stimulant solution was drained out.

Seed germination: After soaking, the seeds were covered with clean, dry and fumigated gunny bags. Seed loaded gunny bags were kept away from direct sunlight. The lid was kept open for germination for a number of hours.

Water was sprinkled on gunny bags every 2-3 hours so that the gunny bags remained wet. After given hours, the seeds were removed from the gunny bags and weighed. About 35 to 40 per cent increase in weight was observed with about + 90 per cent seed germination.

Loading seeds in trays and racking: It was ensured that the trays were clean, washed with cleaning solution and were free from any dust/dirt etc. 'After germination seeds' were transferred on the trays equally and put in the sprout section (lower section where the height between two rows was around 5 inches) of the machine. Trays were distributed evenly on both sides of the alley.

Harvesting (8th day): On 8th day, trays on the rack were ready for harvest on the next day. The fodder mat was taken out from trays to feed them to the livestock. The trays were washed with clean water and cleaning solution before reusing them for the next cycle.

RESULTS and DISCUSSION

Data given in Table 1 show that root length was 7.3, 6.3, 6.2 and 5.6 cm in maize, cow pea, black gram and ragi respectively, which were at par. The root length was statistically higher in maize (7.3 cm) as compared to green gram (4.6 cm), the latter being at par with all other crops except maize. Shoot length was highest in maize (18.1 cm) and black gram (15.2 cm), the two being at par, but latter being at par with green gram (13.4 cm) and cow pea (11.5 cm). Lowest shoot length was recorded in ragi (3.4 cm).

Maximum root biomass per plant was observed in ragi (29 g) and maize (25 g), the two being at par and maize being at par with cow pea (24 g), green gram (21 g) and black gram (20 g). Shoot biomass per plant was recorded maximum in maize (55 g) followed by cow pea (50 g), green gram (49 g) and black gram (47 g), the latter three being at par. Minimum shoot weight per plant was noticed in ragi (37 g).

Highest crude protein content was recorded in black gram (36.50%), green gram (35.95%) and cow pea (31.45%), which were at par, as compared to lowest in ragi (15.85%) and maize (10.55%), the two being statistically at par. Higher crude fibre content was observed in black gram (16.78%), green gram

Plate 1. Installation of the low-cost device

Plate 2. Spreading of sand in shade net

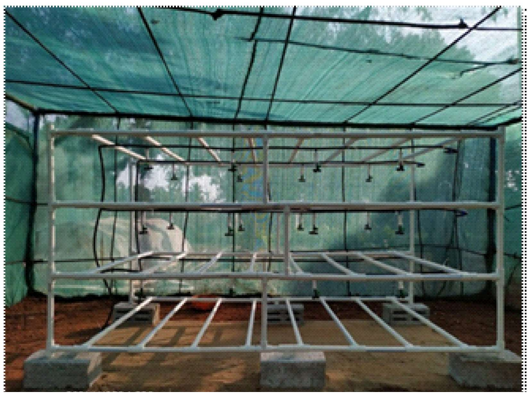

Plate 3. Installation of low-cost hydroponics

Plate 4. Soaking of seeds

Plate 5. Spreading of seeds in the tray

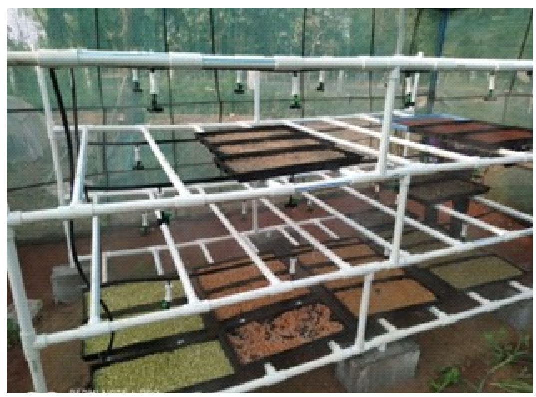

Plate 6. Seed germination in trays

Plate 7. Maize on 8th day

Plate 8. Black gram on 8th day

Table 1. Effect of low-cost hydroponics on different crops and economics of cultivation

Crop	Root length (cm)	Shoot length (cm)	Root biomass /plant (g)	Shoot biomass /plant (g)	Crude protein (%)	Crude fibre (%)	Seed weight (kg)	Fodder production weight (kg)	B-C ratio
Maize	7.3	18.1	25	55	10.55	6.40	1.0	8.6	1:2.8
Black gram	6.2	15.2	20	47	36.50	16.78	1.0	8.3	1:2.4
Green gram	4.6	13.4	21	49	35.95	15.50	1.0	8.0	1:2.3
Cow pea	6.3	11.5	24	50	31.45	15.38	1.0	7.9	1:2.3
Ragi	5.6	3.4	29	37	15.85	15.25	1.0	4.0	1:2.6
SEm(±)	0.77	1.75	2.65	1.98	3.12	1.89	-	-	-
$CD_{0.05}$	1.71	3.91	5.92	4.40	6.95	4.21	-	-	-

Observations made on 8^{th} day

(15.50%), cow pea (15.38%) and ragi (15.25%), all being at par, as compared to lowest in maize (10.55%). Highest fodder production was recorded in maize (8.6 kg), followed by black gram (8.3 kg), green gram (8.0 kg) and cow pea (7.9 kg) with minimum in ragi (4.0 kg).

Maize resulted in highest B-C ratio of 1:2.8, followed by ragi (1:2.6), black gram (1:2.4) and green gram and cow pea (1:2.3 each). The results showed that maize was superior over other crops in case of shoot biomass per plant production, fodder production and B-C ratio.

Barwant et al (2018) reported that the cost effective maize green fodder is prepared within 1-10 days with continuous care in which from one hydroponics rack from 12 kg mature seed 80 kg green maize fodder is formed. From 1 kg, 7 kg green maize fodder is formed and one rack fodder is sufficient for 4-5 cattle for 7 days. For maize hydroponic green fodder production, time required is 10-15 days.

Through hydroponics, it is easy to produce green fodder from maize, ragi, bajra, cowpea, horse gram seeds. Leguminous crops grow well and they give very high yield than the cereal crops. From 1 kg of seed, the green fodder can be increased for about 15-20 kg through hydroponic system. All the nutrients like crude protein, fiber, vitamins and minerals get increased in hydroponic fodder (Arivukodi et al 2020).

Naik et al (2014) reported that the hydroponics maize fodder had higher crude protein (13.30 vs 11.14%) and lower crude fibre (6.37 vs 22.25%) than Napier bajra hybrid. Naik et al (2015) reported that maize grain should be the choice for production of hydroponics fodder. Yields of 5-6 folds on fresh basis and dry matter content of 11-14 per cent are common for hydroponics maize fodder, however, dry matter content up to 18 per cent has also been observed.

Bakshi et al (2017) reported that the biomass yield recorded after nine days was found to be higher (4.16 kg) in 300 g/cm^2 compared to other seed rate, where fodder was produced in low-cost hydroponic system. Fodder production is accelerated by as much as 25 per cent by bringing the nutrients directly to the plants, without developing large root systems to seek out food.

Plants mature faster and more evenly under a hydroponic system than a conventional soil-based system. One kg of un-sprouted seed yields 8-10 kg green forage in 7-8 days (Sneath and McIntosh 2003, Naik et al 2013). The hydroponics maize fodder yield on fresh basis is 5-6 times higher than that obtained in a traditional farm production and is more nutritious (Naik et al 2014).

The crude protein, neutral detergent fiber, acid detergent fiber and Ca content increased, but organic matter and non-fibrous carbohydrates content decreased in the hydroponic green forage compared with the original seed on a dry matter basis (Abdullah 2001, Fazaeli et al 2012, Kide et al 2015, Mehta and Sharma 2016).

Traditional fodder production requires a major investment for the purchase of land, in addition to investment in agricultural machinery, equipment, infrastructure required for pre- and post-harvesting, including handling, transportation and conservation of fodder. It also requires labour, fuel, lubricants, fertilizers, insecticides, pesticides and weedicides.

On the other hand, hydroponic fodder production requires only seed and water as production inputs with modest labour inputs. Hydroponics minimises post-harvest losses, with no fuel required for harvesting and post-harvesting processes. Moreover, in hydroponic systems it takes only 7-8 days to develop from seed to fodder while it takes 45-60 days under traditional systems.

However, the initial investment required for setting up hi-tech, sophisticated, automated commercial hydroponic fodder production systems, with environmental control, plus operational costs is much higher than traditional soil-based fodder production farming. Such hydroponic systems require much more specialized equipment and technical knowledge than are required in traditional farming (Tranel 2013).

According to Ramteke et al (2019), hydroponics green fodder contains more crude protein (13.6% v/s 10.7%) and less crude fibre (14.1% v/s 25.9 %) as compared to traditional fodder production.

Seed for hydroponic cultivation is major input and contributes about 90 per cent of the total cost of production of hydroponics. About 7.0 and 7.5 kg of green fodder is produced in 7 to 8 days. In situations, where conventional green fodder cannot be grown successfully, hydroponics fodder can be produced by the farmers for feeding their dairy animals using low-cost devices.

CONCLUSION

There seems to be a great potential for developing hydroponics technology for fodder production. Hydroponics fodder can be produced and fed in situations where cultivated fodder cannot be grown successfully. The hydroponic fodder/feed technology is gaining importance for small, medium and landless farmers. The technology can also be adopted by progressive dairy farmers who can produce hydroponics fodder for feeding their dairy animals. However, the existing knowledge level about this technology is insufficient, hence, it needs adequate research. There is need to develop specific low-cost devices for production of hydroponics fodder as per local conditions. Better outcome is possible with the strong policy support and technology back up.

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