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Original Research

Standardizing the Growth Conditions for the Production of Hydroponic Fodder Horse Gram

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Abstract

In a fabricated hydroponic fodder production unit biomass yield of hydroponic fodder horse gram in a 2 x 3 factorial design in six replicates was adopted to assess the influence of soaking (8 or 12 hours) and germination time (4 or 8 or 12 hours) of horse gram seeds. Irrespective of the soaking and germination time no significant variation ($P < 0.05$) was observed on the biomass yield. However, numerically higher biomass yield at 12 hours of soaking and 4 hours of germination was observed. To determine the influence of different seed rate (25, 50, 75, 100, 125 and 150 g / sq.ft) on biomass yield of hydroponic fodder horse gram a study was conducted which revealed the highest biomass yield of 5.28±0.32 kg/ kg of seed at a seed rate of 50 g/sq.ft on 6th day of growth.

Keywords: Germination Time, Hydroponic Fodder, Horse Gram, Soaking Time, Seed Rate

Introduction

To enhance the productive and reproductive performance of livestock, green fodder is an essential component in the ration of animals. Quality green fodder should be fed more often to animals, to improve livestock products (Dung *et al.*, 2010). Leguminous fodders are good source of protein, macro and micro minerals which are essential for rumen microbes (Meena, 2014). Decreasing land size for fodder cultivation, scarcity of water, labor requirement, and high cost of fertilization are the critical constraints in green fodder production (MOA, 2014). By the year 2020, green fodder and dry fodder deficit in India are expected to be 64.21 % and 24.91 % respectively and the deficit for crude protein and TDN is likely to be 46.75 and 34.91 % respectively (Vision 2030).

As a solution to this problem, growing hydroponic fodder may control some livestock fodder deficits and can improve animal performance (Rodriguez *et al.*, 2004). Hydroponics technology is coming up as an alternative to conventional method of fodder cultivation to produce fodder for dairy animals (Naik *et al.*, 2015). Growing fodder through hydroponic mode is the transformation of grains into high quality, very lush, highly nutritious, disease free, grass and root combination, animal feed produced in an adaptable and intensive hydroponic unit (Weldegerima *et al.*, 2005).

However, only few studies are available on the techniques viz., soaking and germination time and seed rate for hydroponic fodder horse gram production. Therefore, a study was designed to determine the soaking and germination time and seed rate on the biomass yield of hydroponic fodder horse gram utilizing a locally fabricated hydroponic fodder production unit.

For hydroponic fodder production the grains used should be clean, sound, undamaged or free from insect infestation, untreated, viable and of good quality for better biomass production (Naik *et al.*, 2015). Pre-soaking is important as there is a rapid uptake of water which facilitates the metabolism of reserve material and the utilisation of these reserves for growth and development (Morgan *et al.*, 1992). In case of barley (Morgan *et al.*, 1992) and maize (Naik, 2012) seeds, 4 hours soaking in water is beneficial. Under field conditions, farmers producing hydroponic maize forage have the practice of putting the seeds in a gunny bag tightly and then make it wet and keep for 1-2 days (Naik *et al.*, 2015).

Ghazi N. Al-Karaki (2011) produced hydroponic fodder of alfalfa (*Medicago sativa*), barley (*Hordeum vulgare*), cowpea (*Vigna unguiculata*), sorghum (*Sorghum bicolor*) and wheat (*Triticum aestivum*) after washing the respective seeds from the residues of bleach and further resoaked in tap water overnight (about 12 hours). Krishna murthy (2017) reported that horse gram had to be soaked for 12 hours in tap water and required 36 hours air tight condition for germination and the sprouted seeds had to be spread on plastic tray. Clean seeds of barley (*Hordeum vulgare* L.) were washed and soaked in tap water for 12 hours, and then put in gunny bag for 24-36 hours till root emerged. Thereafter, the sprouted seeds were spread on the hydroponic tray at a rate of 350 gram per tray (Gebremedhin, 2015).

Materials and Methods

Hydroponic fodder horse gram was produced in a locally fabricated hydroponic unit in an area of 100 square feet, with shade net as walls and metal sheet as roof. Irrigation to the fodder was done by manual spraying at 3 hourly intervals during day time. Relative humidity and temperature was recorded using thermo hygrometer.

Experiment 1 – Influence of soaking and germination time for hydroponic horse gram production

A 2 x 3 factorial design in six replicates was adopted to assess the influence of soaking (8 or 12 hours) and germination time (4 or 8 or 12 hours) of horse gram seeds on biomass yield of hydroponic fodder horse gram. Horse gram seeds were soaked in water for either 8 or 12 hours and the soaked seeds were allowed to germinate in a gunny bags respectively for 4 or 8 or 12 hours before being loaded onto plastic trays for fodder production in the fabricated hydroponic unit. The fodder was grown for 6 days. The fodder biomass yield was documented on fresh matter basis by weighing the trays on 6^{th} day and subtracting the weights from respective empty tray weights. Fodder biomass was expressed on fresh matter basis as Kg / Kg seed.

Experiment 2 - Influence of seed rate for hydroponic horse gram production

The second experiment carried out in six replication, was to study the influence of seed rate (25, 50, 75, 100, 125 and 150 g / sq.ft) of horse gram seed on biomass yield of hydroponic fodder horse gram on 6th day of growth. The fodder biomass yield was documented on fresh matter basis by weighing the trays on 6th day and subtracting the weights from respective empty tray weights. Fodder biomass was expressed on fresh matter basis as Kg / Kg seed.

Statistical Analysis

Data collected were analyzed using analysis of variance (ANOVA) using IBM SPSS statistics 20.

Results and Discussion

During the experimental period the maximum and minimum temperature (C°) was 32.03 ± 0.10 and 18.67 ± 0.11 respectively and the maximum and minimum relative humidity (%) was 71.33±0.78 and 33.00 ± 0.64 respectively in and around the fabricated hydroponic unit. However, Weldegerima (2015) for cultivation of hydroponic fodder maize inside a greenhouse with micro sprinklers, maintained a lower temperature range of 22 - 27° C and similar relative humidity of 70 – 80 %

Experiment 1 - Influence of soaking and germination time for hydroponic horse gram production

The results of the effect of soaking time (hrs) and germination time (hrs) of horse gram seeds on the biomass yield of hydroponic fodder horse gram is presented in Table 1. No significant variation ($P < 0.05$) was observed on the biomass yield of hydroponic fodder horse gram irrespective of the soaking and germination times adopted. However, numerically higher biomass yield at 12 hours of soaking and 4 hours of germination was observed. Hence, these time intervals were used for the next experiment.

Table 1: Effect of soaking time (hrs) and germination time (hrs) of horse gram seeds on the biomass yield (Mean* ± SE) of hydroponic fodder horse gram

Treatment	Soaking time (Hours)	Germination time (Hours)	Biomass yield (kg/ kg of seed) ^{NS}
T1	8	4	4.10 ± 0.24
T2	8	8	4.02 ± 0.21
T3	8	12	4.02 ± 0.14
T4	12	4	4.40 ± 0.31
T5	12	8	4.18 ± 0.20
T6	12	12	3.90 ± 0.19

**Mean of six replications; ^{NS} - Non significant*

Krishna murthy (2017) reported soaking time of 12 hours and germination time of 36 hours for horse gram under hydroponic mode with a biomass yield of 5.88 kg. Soaking of seeds is important in hydroponic fodder production. The general purpose of soaking seeds is to hydrate partially the seed to a point where germination processes are initiated but not completed. The water imbibed by the seed while being soaked activates enzymes and facilitates metabolism of the stored starch and protein in seed (Kikuchi *et al*., 2006) and thus, water absorption is the most important event for ensuring nutrient supply to the germinating embryo and to generate energy for the commencement of active germination and seedling growth (Abebe and Modi, 2009). When water is imbibed into the seed it dissolves the plant hormone Gibberellic acid which is transported with water to the aleurone layer where it activates the DNA which translates the amino acids present into enzyme amylase. The amylase is then released into the endosperm where it catalyses the hydrolysis of starch into its component glucose which is used for the metabolic activities of the young growing plant (Dung *et al.*, 2010).

Experiment 2 - Influence of seed rate for hydroponic horse gram production

The effect of seed rate (grams) of horse gram seeds on the biomass yield of hydroponic fodder horse gram is presented in Table 2. Significantly ($P<0.05$) lowest biomass yield (3.53 ± 0.26 kg/ kg of seed) was observed at a

seed rate of 150 (g/sq.ft) and significantly (P<0.05) highest biomass yield (5.28 ± 0.32 kg/ kg of seed) was observed at a seed rate of 50 (g/sq.ft). When seed rate was increased beyond 50 (g/sq.ft) a significant (P<0.05) decline in biomass yield was observed.

The decline observed in biomass yield on decreased seed rate could be attributed to the altered microenvironment. Whereas, the decline observed in biomass yield due to the increased seed rate, could be attributed to competition between individual fodder sprouts for growth, moreover, increase in seed rate of maize seeds results in more chance of microbial contamination in the root mat, which affects the growth of the fodder (Naik *et al*., 2013). Gunasekaran (2018) reported higher seed rate (250 g/sq.ft) for hydroponic fodder maize production. Morgan *et al.* (1992) studied the effect of grain rate 2.5, 5.0 and 7.5 kg/m² on hydroponic fodder production and observed a reduction in DM recovery as grain density increased. At the highest rate of 7.5 kg/m² the root mat became so thick that anaerobic conditions occurred within it towards the end of the growing cycle and the mat began to heat. High seed density also increased the chances of microbial contamination in the root mat which in turn affects the growth of the sprouts (Naik *et al.,* 2015).

Table 2: Effect of seed rate (grams) of horse gram seeds on the (Mean* ± SE) biomass yield hydroponic fodder horse gram

Seed rate (g/sq.ft)	Biomass yield (kg/ kg of seed)
25	3.98^{ab}±0.18
50	5.28^{c}±0.32
75	4.42^{b}±0.22
100	4.24^{ab}±0.20
125	4.04^{ab}±0.37
150	3.53^{a}±0.26

**Mean of six replications; ^{a,b,c} Means bearing different alphabetical superscripts within column for respective hydroponic fodder differ significantly (P<0.05)*

Conclusion

Thus, from the study it can be concluded that soaking time and germination time for fodder horse gram is 12 hours and 4 hours respectively and the optimum seed rate was 50 g / sq. feet for better biomass yield.

Conflict of Interests

There is no conflict of interest.

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