IMPACT OF GROWTH PERIOD ON THE BIOMASS YIELD AND DRY MATTER CONTENT IN SORGHUM AND MILLET HYDROPONIC FODDERS

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ABSTRACT
The progressive increase in biomass yield and dry matter loss associated with hydroponic fodder production may be influenced by the seed type and duration of growth. This study determined the effect of the sprouting period on biomass yield and dry matter (DM) loss in hydroponic fodder produced from white sorghum, red sorghum (*Sorghum bicolor*), and millet (*Pennisetum glaucum*) seeds. Four replicates of 500 g of each seed type were primed by soaking them in water for four hours, arranged on wooden racks placed in a naturally lit and airy room and watered daily for 8 days to produce the hydroponic fodders. Another 500 g of each seed type served as the control in a randomized complete block design (RCBD). The moisture (MC) and DM contents of the fodders were determined on the 1st, 4th, 6th, and 8th days and percentage changes in data were calculated. There were progressive increases in fodder weights such that by the 8th day the percentage increases in the initial 500 g seeds were 201.60, 236.80, and 280.80% for the white sorghum, red sorghum, and millet fodders, respectively. The DM contents decreased progressively from 89.72, 89.96 and 91.92% in the white sorghum, red sorghum, and millet seeds to 19.49, 19.90 and 13.75%, respectively on the 8th day. To reduce the DM loss from millet hydroponic fodder, there may be a need to harvest it two days earlier than the sorghum fodders.
Keywords: Sorghum, biomass yield, millet, hydroponics fodder, dry matter loss

INTRODUCTION

In hydroponics production systems, media other than soil such as water or a mixture of essential nutrients dissolved in water are used in cultivating plants under a controlled environment. Hydroponic fodder is produced from grains germinated and grown for a short period under acceptable growing conditions inside a growing room (Naik *et al.,* 2015; Sriagtula *et al.,* 2021). Hydroponic fodder has the advantage of being essentially organic because herbicides, pesticides, and other chemicals are not applied during its production (Girma and Gebremariam, 2018; Bari *et al.,* 2022). It is rich in protein, metabolizable energy, minerals, vitamins, and digestible fibers, and therefore highly palatable to animals (Farghaly *et al.,* 2019; Bari *et al.,* 2022). Under a good hydroponic fodder production system, the cereal sprouts can achieve a height of 15 - 20 cm and a weight change of 6 to 8 folds in 8 to 10 days (Kantale *et al.,* 2017; Upreti *et al.,* 2022) through metabolic activities that result in the transformation of complex carbohydrates, proteins, and fats into digestible simple sugars, essential amino acids, and fatty acids respectively (Farghaly *et al.,* 2019). It is therefore increasingly being used to replace the expensive concentrate feeds in a bid to reduce the cost of livestock production and products (Upreti *et al.,* 2021).

Hydroponic fodder production technology could be adopted by the ruminant farmers in places like northern Nigeria where shrinking pastoral lands has led to conflicts between crop farmers and pastoralists (Kubkomawa, 2016) and in urban and peri-urban areas where the situation permits only intensive livestock production (Upreti *et al.,* 2022). It is also suited to areas suffering from chronic water shortages and poor or limited irrigation infrastructure (Bakshi *et al.,* 2018). Several kinds of cereal such as maize, oats, barley, wheat, sorghum, alfalfa, cowpea, etc. have been used for hydroponic fodder production although with varying results on yields and nutrient contents (Karki *et al.,* 2012; Naik *et al.,* 2014; Adebiyi *et al.,* 2018; Chana *et al.,* 2021; Upreti *et al.,* 2022). It is therefore necessary to evaluate local seed varieties intended for use in hydroponic fodder production. For example, Upreti *et al.* (2022) in their study reported that oat is better for fodder yield with modest quality fodder, while wheat produces better quality fodder with modest yield.

Hydroponic fodder production has certain disadvantages such as the high hi-tech and cost of the greenhouses usually erected for its production. Simpler and cheaper growing environments such as poly-houses or simple sheds made of a cemented floor, walled with nets and roofed with aluminum sheets and surrounded by trees to provide natural cooling and ventilation have however been designed for smallholder farmers (Naik *et al.,* 2015; Upreti *et al.,* 2022). Inexpensive aluminum or plastic trays could be used for the sprouting process, while seeds could be irrigated manually using a knapsack sprayer or watering can (Chana *et al.,* 2021). Another major disadvantage of hydroponic fodder production is the progressive dry matter loss associated with the growth of the fodder (Shtaya, 2004; Kantale *et al.,* 2017). This loss could be as high as 75 percent or more of the dry matter content of the seed during the fodder production period (Ramteke *et al.*, 2019; Bari *et al.*, 2022), and is usually influenced by the grain type and duration of growth (Chrisdiana, 2018; Salo, 2019).

This study determined the effect of the sprouting period on yields and dry matter losses in hydroponic fodder produced from sorghum and millet grains.

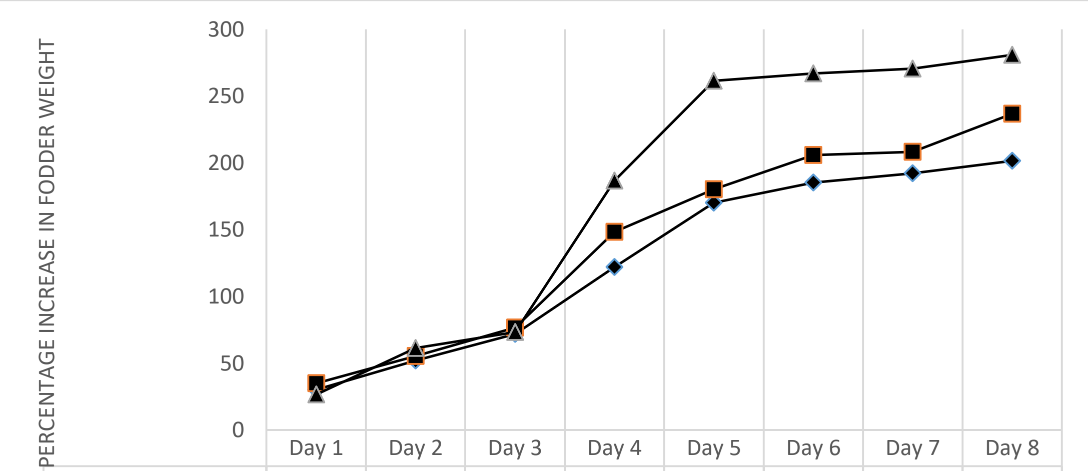
MATERIALS AND METHODS

Three common grains, white and red sorghum (*Sorghum bicolor*) and pearl millet (*Pennisetum glaucum*) were purchased from wholesalers in a local market at Owerri, southeastern Nigeria, and used for the experiment, within two weeks of their collection. Owerri lies between latitude 5°29'20.6124"N and longitude 7°1'3.3168"E with an elevation of 75.023 (CountryCordinates.com/Owerri). The seeds were sorted to remove foreign substances such as stones, chaff, metals, and insects. Four replicates of 500 g of each seed type were weighed with a digital scale (Mode lSF-400, Exclusive SencorDisc Technology, China) into plastic buckets and soaked liberally with clean borehole water for four hours to prime or activate them. Thereafter, the water was drained and the seeds were transferred to plastic trays of known weight measuring approximately 12 x 16 inches and a depth of 1 inch, and perforated at one end to allow for draining of excess water. The trays were arranged on a wooden rack in an airy, naturally lit room, and watered three times daily for 8 days to produce the hydroponic fodders. Another 500 g of each seed type was spread on similar plastic trays and kept on the rack to serve as the control. The experimental design is therefore a randomized complete block design (RCBD).

The seeds were irrigated three times daily in the morning, afternoon, and evening with clean borehole water to produce the various sorghum and millet hydroponic fodders. The weight of each sample was determined daily in the mornings before watering for 8 days. The fodder in one tray was collected on the 1st, 4th, 6th, and 8th days, and used to determine the moisture (MC) and dry matter (DM) contents of the fodders according to the method described by AOAC (2010). Data generated were analyzed using descriptive statistics such as graphs and histograms with "Microsoft Excel (15)".

RESULTS AND DISCUSSION

Figure I shows the percentage increase in the weights of hydroponic fodders produced from sorghum and millet seeds during eight days of sprouting. The fodder weights increased progressively during the sprouting period such that on the 8th day the percentage increases on the initial 500 g seeds were 201.60, 236.80, and 280.80% for the hydroponic white sorghum, red sorghum, and millet fodders, indicating a higher weight increment in the millet. The growth trend was generally similar till the 3rd day, beyond which the millet value became much higher than the rest, while the red sorghum also recorded a slightly superior performance to the white sorghum. There was a general 'plateauing effect' on fodder weights beyond the 5th day which was more noticeable in the millet than the sorghum values, probably indicating the approaching depletion of the nutrients reserves in the seeds.



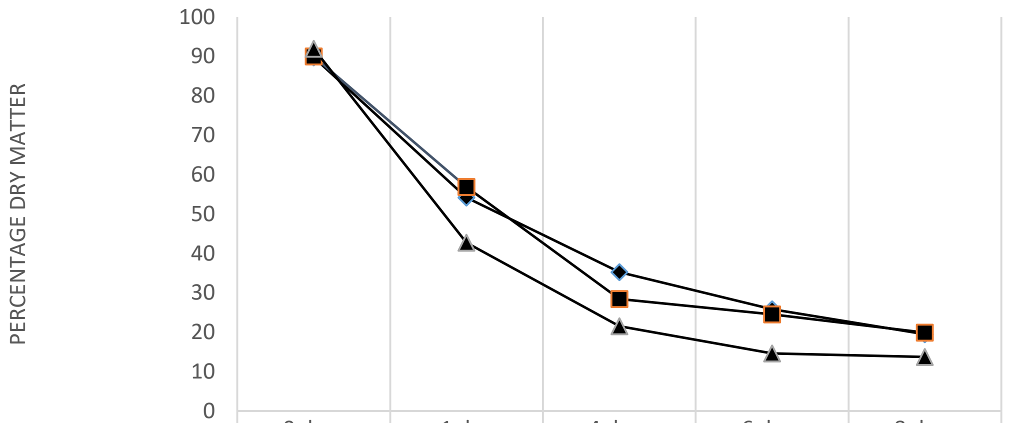
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
White sorghum	30.35	52.07	71.93	121.93	170.1	185.4	192.2	201.6
Red sorghum	35	55.4	76.73	148.47	180.3	205.8	208.2	236.8
Millet	26.75	61.33	73.3	186.73	261.4	266.9	270.6	280.8

Fig. I: Percentage increase in the weight of hydroponic fodder during eight days of sprouting

Sriagtula *et al.* (2021) reported a much higher percentage increase in weight (263.64 to 393.51%) on the 7th day for hydroponic sorghum fodders, while Ghazi *et al.* (2011) reported that as much as 15 kg of hydroponic fodder could be produced from 1 kg of grain after 8 days of growth, which translates to 1400%

increase in fresh weight. The superior results may be attributed to the influence of factors such as seed type, quality and density, nutrient supply, watering practice, and several other environmental conditions (Carmi *et al.*, 2006; Chrisdiana, 2018).

Figure II shows the effect of the sprouting periods on the percentage of dry matter (DM) contents of hydroponic fodders produced from the local seeds. There were progressive decreases in the dry matter contents of the fodders with an increase in sprouting days, such values decreased from 89.72, 89.96 and 91.92% in the seeds to 19.49, 19.90, and 13.75% on the 8th day in the fodders produced from white sorghum, red sorghum, and millet respectively. The loss in DM was generally most marked during the first four days of sprouting. The loss in DM was also much higher in the millet than in the sorghum fodder.



	0 days	1 day	4 days	6 days	8 days
White sorghum	89.72	54.14	35.29	25.84	19.49
Red sorgum	89.96	56.84	28.44	24.56	19.9
Millet	91.92	42.72	21.51	14.61	13.75

Fig. II: Effect of the sprouting period on the dry matter contents of hydroponic fodders produced from local grains

Figure III showed that by the 8th day of sprouting, the white and red sorghum-derived fodders have lost 78.28 and 77.88% DM, while the millet-derived fodder has lost 85.04% DM. Several earlier studies have identified DM loss as a major disadvantage of hydroponic fodder production. For example, Kantale *et al.* (2017) reported 12.3% DM at day 8 in hydroponic wheat fodder produced in a modern sprouting house, while Shtaya (2004) observed 17 and 25% loss of total DM of wheat after 5 to 7 and 12 days of sprouting respectively. Bari *et al.* (2022) also reported a remarkable decrease in the DM content of hydroponic wheat fodder with the advancement of growing days with the value being less than 12.50% of the 90% DM in the initial wheat grain by day 8 of sprouting. Chrisdiana (2018) reported a DM value of 27.04% in 8th-day sorghum hydroponic fodder, while Sriagtula *et al.* (2021) reported a range of 11.41 to 15. 58% and 7.51 to 10.94% DM in 7 and 10th-day sorghum hydroponic fodders in agreement with the reports by Ramteke *et al.* (2019).

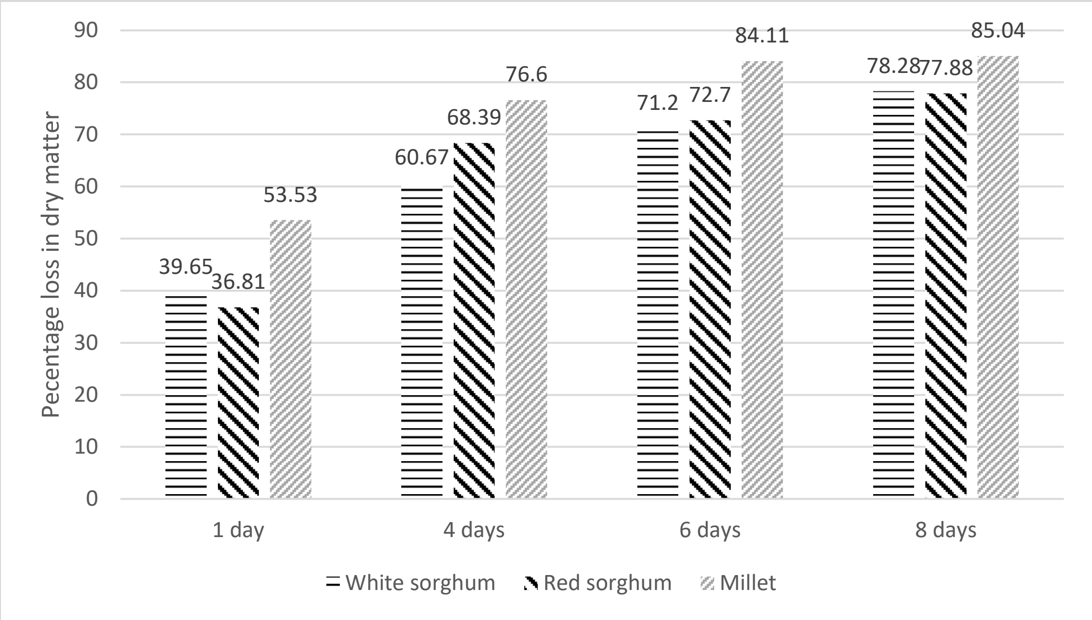


Fig. III: Percentage losses in dry matter contents of hydroponic fodder produced at different periods from local grains

Fazaeli *et al.* (2012) attributed this sharp reduction in the DM content to a large uptake of water during the germination of seed that causes a remarkable increase in moisture content in hydroponic fodder as shown in figure IV of the present study. The initial moisture seeds contents increased from 10.28, 10.04, and 8.08 percent in the white sorghum, red sorghum, and millet grains to 45.86, 43.16 and 57.28% in 24 hours and subsequently to 64.71, 71.56 and 78.49% respectively in the hydroponic fodder by the 4th day. By the 8th day of growth, the moisture contents of the fodders ranged from 80.10 to 86.25, with the millet fodder recording the higher figure.

Saini (2012) attributed the increase in moisture in the body of the plant during germination to growth activities in the root and stem.

The high absorption of water supports higher plant growth by increasing the metabolic activities in the seed, resulting in DM loss (Saini, 2012; Morsy *et al.*, 2013).

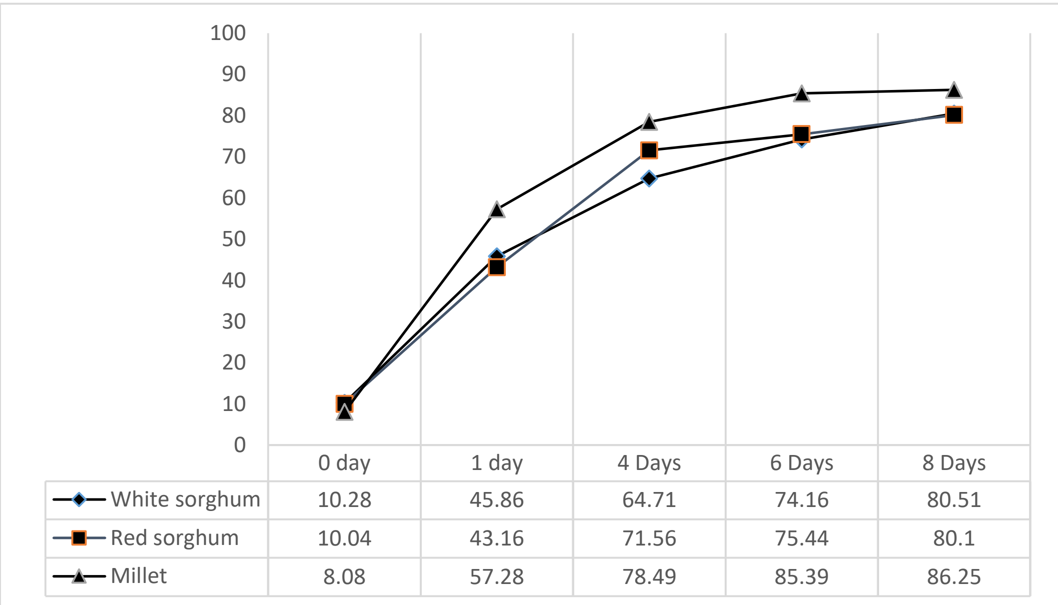


Fig. IV: Effect of the sprouting period on the moisture contents of the hydroponic fodders produced from local grains

There is therefore a consequent decline in the DM content with an increase in the fresh weight which occurs during the sprouting process that is primarily attributed to the imbibition of water and metabolic activities that diminishes the food reserves (mainly carbohydrate and energy) of the seed endosperm without any passable replenishment from photosynthesis by the young plant (AlKaraki and Al-Momani, 2011; Adjlanea *et al.*, 2016: Bari *et al.*, 2022). Since photosynthesis commences at about the 5th day of sprouting, when the activation of chloroplasts occurs, there is not enough time for any significant DM accumulation by the 7 - 8th day of sprouting (Dung *et al.,* 2010).

CONCLUSION

Sprouted sorghum and millet hydroponic fodder weights increase progressively during a growing period of one to eight days with the percentage increases from the initial 500 g seeds being 201.60, 236.80, and 280.80% DM for the white sorghum, red sorghum, and millet fodders on the 8th day, indicating a higher increase in the millet. The dry matter loss was also progressive with the 8th day white and red sorghum losses being 78.28 and 77.88% respectively, while the loss in the millet fodder was higher at 84.11 and 85.04% DM on the 7th and 8th days respectively. To reduce the loss of dry matter from millet hydroponic fodder, there may be a need to harvest it a day earlier that the sorghum fodders.

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