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Evaluation of nutrient solution dose and harvest time on forage sorghum (*Sorghum bicolor* L. Moench) in hydroponic fodder system

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Abstract. This study aims to evaluate the effects of adding nutrient solutions and different harvest ages to the productivity and quality of sorghum forage hydroponically. The study was conducted experimentally using a 3x3 factorial randomized block design with 5 groups. Factor A dose of commercial nutrient solution (0, 3, and 5 ml/l). Factor B is the age of harvest (7, 10, and 13 days). The observed variables were plant productivity, nutrient, fiber fraction, and Hydrogen cianide (HCN) content. The results showed that there was a very significant interaction ($P<0.01$) between the nutrient solution factor and the age of harvest on the content of dry matter (DM), crude fiber (CF), ether extract (EE), ash, and nitrogen free extract (NFE), while the single factor of harvest age had a very significant effect ($P<0.01$) reducing the content of DM, CP, EE, and NFE. There was no interaction between the addition of nutrient solution and age of harvest to the content of fiber fractions. A single factor in nutrient solution significantly increased ($P<0.01$) content of acid detergent fiber (ADF), neutral detergent fiber (NDF), cellulose, and lignin, but not hemicellulose. The conclusion is the addition of a nutrient solution to increase growth and fresh production, the content of CF, ash, ADF, NDF, cellulose, lignin and HCN, but a decrease in the content of DM, CP, EE, and NFE. The longer the harvest age will increase growth and fresh production, the content of CF, ash, ADF, cellulose, lignin and HCN, but reduce DM, CP, EE, and NFE.

Keywords: fiber fraction, numbu, nutrition content, sprout, sweet sorghum

1. Introduction

Forage needs will increase as the livestock population increases. Land area is one of the factors determining forage production. Low forage production is partly caused by the decreasing land area for planting forages due to land conversion. Another obstacle in providing forages is the fluctuation of production, mainly influenced by climate. The forage production is high in the rainy season but low in the dry season due to lack of water shortage. Therefore, technology alternatives that can be the solution for the forage needs are required. Continuous forage production at all times without being influenced by season and land shortage can be realized through a hydroponic system.

Hydroponics is the cultivation of plants in planting media other than soil and uses a mixture of essential nutrients dissolved in water with environmental control systems [1]. Hydroponic technology is an alternative for the conventional method of forage plant cultivation. Forages produced with hydroponic forage fodder (HFF) have high protein content and metabolism energy and are easily digested by animals [2]. Seeds are rich in nutrients that are useful as places to store food and energy reserves for the germination process. During the germination process, there is a breakdown of nutrients

such as carbohydrates, fats, and proteins into dissolved forms due to enzymatic activity. This event causes nutrients in the seeds to undergo hydrolysis like carbohydrates, protein, and fats hydrolyzed into simpler compounds. Hydrolysis increases the concentration of amino acid, dissolved sugar, and fatty acid in seeds for the growth. Therefore, the use of the hydroponic technique for forage planting is expected may overcome the lack of nutrient content in the feed, especially essential vitamins needed by the livestock.

The need for forage is probably fulfilled with HFF, giving a short time of forage production (harvest time). A hydroponic system is often carried out on cereal crops. Sorghum is one of the cereal crops often used as forage plants. The basic principle of HFF is that cereal crops respond to water supply and nutrient in order to germinate, grow, and produce forages in a short time. This system can produce fresh forage, depending on the kinds of seeds, 7-9 times [3]. Germination process will grow green buds and carpet-formed layers of roots, which can be harvested for animal feed.

A hydroponic fodder requires nutrients, like conventional plant cultivation, to obtain optimal production. Nutrient solutions are one of the determining factors of crop yield and quality [4]. A lot of studies have been conducted to determine the dosage of nutrient solution in the water for the growth and production of forages. However, in this germination process, leaves cannot function as an organ for photosynthesis. Thus, the growth of sprout depends on the food supply in the seeds [5], and as a result, the use of nutrient solution may not be efficient. Another factor that can affect forage production is the harvest age. Generally, HFF is harvested in a short time, that is 7 days [6]. The increasing harvest age will enhance nutrient needs to support the increase of fresh forage production due to the increase in the plants' height.

Based on these thoughts, it is necessary to conduct a study to evaluate the effects of the use of nutrient solutions and different harvest ages on the growth and production of sorghum biomass with HFF. Specifically, the aim of this research is to evaluate the effects of the addition of the nutrient solution and different harvest time on the quality and quantity of HFF.

2. Materials and methods

2.1. Material methods and design

The investigation was conducted at Laboratory of Nutrition of Ruminants, Faculty of Animal Science, Andalas University. This research used sorghum seeds of numbu variety, commercial nutrient solution (AB Mix), and water. The equipment used a pair of wooden rack 2 x 0,5 x 1,5 m, 30x22x5cm plastic trays, a sprayer, a ruler, a thermometer, a digital luxmeter (TM1010), lamp etc. The nutrient content of sorghum seed is presented in Table 1.

Table 1. Nutrient content of sorghum seed (DM %).

DM	Ash	OM	EE	CF	CP	NFE
97.73	1.58	96.14	4.21	6.70	8.94	76.31

2.2. Experimental design

This research used a completely randomized factorial design 3x3 in 5 replicates. Factor A consists: A1 = no solution; A2: addition of commercial solution (3 ml/l); A3: addition of commercial solution (5 ml/l). Factor B1 = harvest time 7 days, B2 = harvest time 10 days, and B3 = harvest time 13 days.

Hydroponic unit: A hydroponic unit was constructed in a room using two wooden racks were with 2 x 0.5 x 1.5 m length, width and height respectively. The sorghum seed sown in 45 plastic trays (231 g/tray) arranged in racks with manual sprayer watering. The room temperature was 25^{0}C and 88% humidity, continuous lighting was also provided for the 5th day after sowning until the 13th day. We used one pairs of lamps Hannochs LED 30 W an average lights intensity of about 72%. The measurement of light intensity was done at five spot of the room by digital luxmeter. In order to manage and control moisture of system, watering was carried out manually at 08.00 am, 12.00 am and 17.00 pm.

2.3. Procedure of the research

Sown of seed by hydroponic: The selection of sorghum seeds was carried out by washing the seeds to remove floating seeds. Then, the seeds were soaked for 24 hours in hydrochloride solution, a disinfectant solution, to prevent fungi. The seeds were sown in a plastic tray and covered by black plastic for 4 days. The nutrient solution was sprayed on the seed surface on the basis of 3 times a day to make the seeds always be moist. The forages were harvested at the age of 7, 10, and 13 days, in accordance with the treatment, to observe the growth and nutrient content.

2.4. Observed variables

Observed variables were sprout viability (%), plans' productivity (plants' height, fresh weight and dry weight production), nutrient content (DM, ash, CP, EE, CF, NFE), fiber fraction content (ADF, NDF, cellulose, hemicellulose, lignin), and HCN content.

Viability of the sprout: The growth of the sprout was measured at the end of day 7 of germination [7]. Germination percentage = (sprouts / total number of seeds in a test) x 100 [8].

2.5. Laboratory analysis

Each harvested hydroponic sorghum fodder were dried under the sunlight for 2 days and in the oven at 110^{o}C for 8 hours then ground to 1-mm mesh screen to analyze the nutrient content by proximate analysis [9], fiber fraction [10], and HCN [11].

2.6. Data analysis

The obtained data were analyzed using analysis of variance and Duncan Test using Statistical Product and Service Solutions (SPSS) software version 16.

3. Results and discussions

3.1. The effect of treatment on germination percentage of sprouts sorghum

Our findings of test the percentage of sorghum seed germination, that 97% of 100 seeds were germinated, it was indicated that the sorghum seeds used were of good quality and had high viability. The rate of germinating is one of the ways to determine seeds' viability. It is a benchmark for the ability of seeds to grow normally in an optimum condition. The test principle for the power to germinate is by testing the number of seeds and determining the percentage of the seeds that can grow or germinate normally in a specified time period. In this research, the test was conducted using tissue paper substrate and calculating the amount of the seeds which germinate during the 7 days. The seeds are said to germinate if the radicle has grown to an extent of ±2 mm [7]. In accordance with the present results, the high the viability of seed was because the sorghum seeds grew well and were physiologically mature with adequate moisture. Consistent with the literature [12] states, good quality seeds are characterized by germination capacity and high vigor which is >80%.

Growth and production of biomass of forage sorghum: The hydroponic growth and the production of forage sorghum are presented in Table 2. The result of the statistical analysis showed that there was an interaction between the dose of nutrient solution and different harvest age toward fresh production, but no interaction on dry matter production of hydroponic forage fodder sorghum. The effect of a single factor of harvest age showed very significant effects ($P<0.01$) on the plant's height and dry matter production. Treatment A2B3 and A3B3 resulted in higher plants than other treatments with value 20.35 cm and 20.98 cm respectively.

Table 2. Growth and productivity of sorghum forage fodder.

Parameters		B1	B2	B3	Mean
Plant's high (cm)	A1	9.72±0.57^{f}	20.72±3.63^{cd}	18.15±0.58^{de}	16.20±5.25^{A}
	A2	15.42±0.33^{e}	21.35±3.77^{bc}	24.27±0.82^{ab}	20.35±4.33^{B}
	A3	15.15±0.95^{e}	21.74±4.04^{bc}	26.05±0.66^{a}	20.98±5.15^{B}
Mean		13.43±2.78^{B}	21.27±3.56^{A}	22.82±3.56^{A}	
Fresh production (kg/ tray)	A1	0.84±0.16^{E}	0.97±0.07^{D}	0.99±0.03^{D}	0.94±0.08^{C}
	A2	1.11±0.02^{C}	1.41±0.02^{B}	1.44±0.07^{B}	1.32±0.16^{B}
	A3	1.14±0.03^{C}	1.43±0.03^{B}	1.51±0.04^{A}	1.36±0.17^{A}
Mean		1.03±0.13^{C}	1.27±0.22^{B}	1.31±0.24^{A}	
Dry matter production (g/tray)	A1	132.30±3.07	105.99±8.75	85.95±2.99	108.08±20.32
	A2	133.04±10.39	108.59±1.53	93.59±3.93	111.74±17.86
	A3	130.17±5.22	107.71±2.00	91.85±4.13	109.91±16.69
Mean		131.84±6.55^{A}	107.43±4.99^{B}	90.46±4.83^{C}	

Note: Means in the same column/row with different superscript differ significantly (P<0.01). A1=no nutrient solution, A2=addition nutrient solution 3 ml/l, A3= addition nutrient solution 5 ml/l, B1= 7 DAS, B2= 10 DAS, B3= 13 DAS.

Treatment A2B3 and A3B3 resulted in higher plants than other treatments with value 20.35 cm and 20.98 cm respectively because plants require sufficient nutrient input. The germination process utilizes energy and nutrient reserves from the seeds, but in this study, the dose of nutrient solution 3 ml/l and 5 ml/l with a harvest age of 13 days resulted in the same plant height. This shows that in order to support its growth, plants need adequate input of nutrients and time to grow. This is consistent with the statement of [13] that nutrient solution will help improve metabolism in plants that are reflected in growth. Better growth in treatments that get added nutritional solutions results in higher fresh production. Treatment of A2B3 and A3B3 with a dose of nutrient solution respectively 3 ml/l and 5 ml/l resulted in growth that was not significantly different (P> 0.05) because in this study using a closed hydroponic system, where the loss of nutrients from the root environment is minimum. These results reflect those of [14] who also found that the concentration of the nutrient solution can be reduced by up to 50% without adverse effects on biomass in geraniums.

3.2. The effect of treatment on nutrition content of forage sorghum

Nutrition content of hydroponic forage fodder is presented in Table 3. Results of statistical analysis showed that there was an interaction between the dose of nutrient solution and different harvest age on dry matter, CF, EE, ash and NFE content (P<0.01). The effect of a single factor harvest age showed very significant effects (P<0.01) on CP content. In this study, increasing harvest age was decreasing DM, CP, EE, and NFE content but the CF and ash content were increased.

The addition of nutrient solution and longer harvest time showed a trend of increasing fresh forage production. In this study, the highest fresh production was produced at a combination of A3B1 treatment, namely 1.51 kg/tray. The longer the harvest time will produce higher forage biomass, the same was also reported by [15]. This finding was also reported by ([16]; [17]; [18]) which states that sorghum plant height increases with increasing plant age. Plant growth depends on the availability of nutrients in the seeds, the longer the germination of plants will require additional nutrients to support its growth. This

outcome is in line with that of [5], who found sorghum growth at the age of 3-10 days after sowing (DAS) depends on nutrition and food reserves in the seed. The increase in harvest age results in an increase in fresh production, but DM production on forage fodder sorghum was decreased hydroponically in this study, it is in line with the findings of [19]. This is due to the increase of water retained in the body of the plant during germination due to root and stem growth [20].

Table 3. Nutrients content of sorghum forage fodder (% DM).

		B1	B2	B3	Mean
DM	A1	15.58±0.45^{A}	10.94±1.15^{C}	8.60±0.21^{D}	11.71±3.08^{A}
	A2	11.96±0.71^{B}	7.68±0.09^{E}	6.50±0.40^{F}	8.72±2.46^{B}
	A3	11.41±0.19^{BC}	7.51±0.25^{E}	6.06±0.29^{F}	8.33±2.35^{C}
	Mean	12.99±1.97^{A}	8.71±1.75^{B}	7.05±1.18^{C}	
CP	A1	15.55±0.30	15.31±0.21	15.39±0.29	15.41±0.27
	A2	15.99±0.73	15.33±0.13	15.17±0.38	15.49±0.58
	A3	16.22±0.79	15.33±0.19	15.48±0.36	15.67±0.62
	Mean	15.94±0.97^{A}	15.32±0.16^{B}	15.35±0.35^{B}	
CF	A1	11.12±0.22	10.95±0.15	11.00±0.21	11.03±0.19
	A2	11.44±0.52	10.97±0.09	10.85±0.77	11.08±0.41
	A3	11.60±0.56	10.96±0.13	11.07±0.26	11.21±0.44
	Mean	11.40±0.48^{A}	10.96±0.11^{B}	10.98±0.25^{B}	
EE	A1	5.76±1.45^{ab}	5.29±0.59^{ab}	6.74±0.97^{a}	8.44±0.15
	A2	6.04±1.52^{ab}	4.27±1.14^{b}	5.51 ±1.90^{ab}	8.49±0.31
	A3	6.61±0.51^{a}	5.46±0.56^{ab}	4.30±2.14^{b}	8.59±0.34
	Mean	6.10±1.24^{a}	5.00±0.42^{b}	5.51±1.89^{ab}	
Ash	A1	1.93±0.55	3.21±0.34	3.86±0.35	3.00±0.91^{C}
	A2	2.83±0.63	5.80±0.47	6.09±0.18	4.91±1.58^{B}
	A3	2.65±1.43	6.93±0.41	7.76±0.54	5.78±2.46^{A}
	Mean	2.47±0.97^{C}	5.31±1.65^{B}	5.90±1.69^{A}	
NFE	A1	66.78±0.28^{A}	58.00±4.21^{B}	53.89±1.62^{CB}	58.44±5.73^{A}
	A2	55.19±5.28^{CB}	53.11±2.29^{C}	46.14±1.62^{A}	52.29±6.70^{B}
	A3	54.92±1.68^{CB}	45.12±1.38^{A}	47.56±2.80^{A}	49.20±4.71^{C}
	Mean	57.76±6.06^{A}	52.07±6.10^{B}	49.20±3.98^{C}	

Note: Means with different superscripts in uppercase and lowercase differ significantly at P<0.01 and P<0.05, respectively. A1=no nutrient solution, A2=addition nutrient solution 3 ml/l, A3= addition nutrient solution 5 ml/l,, B1= 7 DAS, B2= 10 DAS, B3= 13 DAS. DM=Dry matter, CP-crude protein, CF=crude fiber, EE= extract ether, NFE=nitrogen free extract.

The highest DM content was produced in A1B1 treatment, and the lowest was produced by A2B2 and A2B3 with 15.58%; 6.50%; 6.06%, respectively. The lower DM content in the treatment that

received the addition of nutrient solutions was due to better germination growth (Table 2). Increased growth in the treatment of nutrient solution is reflected by an increase in the fresh weight of sorghum forage biomass. This is due to the high absorption of water and nutrients during germination to support higher plant growth and production, but this also results in high DM loss. In accordance with [21] that water absorption will increase metabolic activity in seeds and cause loss of DM (starch) during the germination process. [20], states that the addition of nutrients plays a role in increasing the percentage of water content through increasing root growth and causing increased water absorption in plant bodies. It is a reason for the decrease in DM production.

In this study, there was a change of nutrient content such as the decrease of DM and starch content and the increase of CP, CF, EE and ash content during germination. This is in line with [22] that there is a biochemistry reaction in seeds that leads to the loss of DM during the germination process. Carbohydrates in the seeds are metabolized as an energy reserve in the germination process. This is supported by low NFE content in treatments that get the added nutrition solution in this research (A2 and A3). In line with [23] that germination facilitates the enzymatic degradation of starch to simple sugars to provide energy for seed development. However, in the germination phase, plants cannot synthesize carbohydrates by themselves. Thus, due to the high growth, DM content in the treatments that get the added nutrition solution to be lower. This is supported by [22] that plants cannot carry out photosynthesis activity during the germination process. There are similarities with [3] that hydroponic systems make a decrease in dry matter and carbon up to about 10-14 days of growth.

The increase in harvest age produces a decrease in DM content. It is the carbohydrates and triacylglycerol are hydrolyzed and metabolized and utilized for plant growth and development during germination so that there is a decrease in grain dry matter. This fact explain by [24] that the longer the times cause the higher the loss due to respiration on the sprouting. DM content in the sorghum fodder in this research varied from 6.06 to15.58%, which is lower than that in [25] was 19%.

The highest CP content in this study was obtained in the B1 treatment (15.94%) and decreased in the B2 and B3 treatments respectively 15.32% and 15.35%. Similar results were reported by ([26]; [27]) that crude protein decreases in sorghum, and quinoa [28] during germination, which is associated with protein degradation by proteases. In addition, increased plant growth (plant height and root length) is associated with increased cell wall material content in plants. In the A2 and A3 treatment, the CP content dropped due to the rise of the plant growth (plant's height and root's length) that is related to the increase in the material content of cell walls in the plants. Protein and fiber content is inversely proportional to nutrient composition so that an increase in fiber content causes a decrease in protein content. This finding was also reported by [1], changes of starch in seeds into fiber and pectin in roots and shoots during germination.

The highest CF content produced in A2B3 and A3B3 treatments were 25.78% and 23.6%, respectively, this condition was related to the height of plants produced in the treatment was also the highest. Plant height correlates with cellulose, hemicellulose and lignin accumulation because plant cells are built by cell walls consisting of cellulose, hemicellulose, and lignin [29]. The increasing CF content in this study was due to a decrease in DM especially carbohydrate and EE content.

The EE content decreases during the germination phase, the same result was also reported by [30]. It is because lipids are used for the process of respiration, hydrolysis, and utilization of fat as an energy source for biochemical reactions during germination ([31]; [30]; [32]) This finding was explained by [33] that during germination metabolic activity occurs to convert fat into sugar.

The highest ash content was in the A3B3 treatment, and the lowest was found in the A1B1 treatment with values of 7.76% and 1.93%, respectively. Increased ash content occurs due to the addition of nutrient solutions so that nutrients will be retained in the body of the plant along with water absorption. On the other hand, the germination process causes an increase in the activity of the phytase enzyme which can free the mineral bonds with organic compounds so that it is measured to be ash. In accordance with [34] that an extraordinary increase in phytase activity during germination helps reduce phytic acid, which binds minerals further leading to an increase in mineral availability. This finding in line with [33] that as phytate content decreases, the bioavailability of phosphorus and minerals increases. It is in line

with [34] that an extraordinary increase in phytase activity during germination helps reduce phytic acid, which binds minerals further leading to an increase in mineral availability.

There is an interaction that occurred between nutrient solution and harvest age to the content of NFE forage fodder sorghum hydroponically. In this study, the lowest NFE content was found in the A2B3 and A3B3 treatments at 46.14% and 47.56%, respectively. There is a decrease in NFE in the treatment with the addition of nutrient solution and higher harvest age due to plant growth and higher fresh production. In accordance with [19] that the energy content is reduced during sprouting because the energy stored in the seeds is used and lost during the germination process.

Higher NDF, ADF, cellulose, and lignin contents in A2 and A3 than those in A1, its were related to DM content. The treatments of A2 and A3 resulted in lower DM content than A1 treatment because A2 and A3 treatments produced better growth so that the use of carbohydrates as an energy source for germination was higher. Consequently, DM content in A2 and A3 treatments was lower than the A1 treatment. It is suitable with the statement of [35] that germination will increase the activity of β-amylase enzymes to hydrolyze carbohydrate as an energy source for the germination process, which leads to the loss of DM content.

In addition, loss of DM during the germination process is also caused by respiration, namely the use of starch as an energy source during germination [3]. Besides that, the loss of DM during the germination process is also caused by the change of non-structural carbohydrates in the form of starch in seeds into structural carbohydrates in building plant bodies in the form of cell walls. [1] explain that germination commences due to the water imbibition in seeds that activates enzymes converting the starches stored in the endosperm into simple sugar, which produces energy and releases carbon dioxide and water, leading to the loss of DM and the change of starches in seeds into fiber and pectin in the root and shoot. A comparison of the findings with those of other studies confirms the loss of DM due to enzymatic hydrolysis of starch and degradation of cellular materials such as protein, fat, and carbohydrates thereby increasing fiber content. Besides the increase in fiber due to . increased cellular structure in plants during germination consisting of cellulose, hemicellulose, and lignin as plant cells [29].

3.3. The effect of treatment on fibre fraction content of forage sorghum

The fiber fraction content of forage sorghum is presented in Table 4. The result of the statistical analysis shows that there is no interaction ($P>0.05$) between the dose of nutrient solution and harvest age on fiber fraction content in forage sorghum. Increasing nutrient solution dose had a highly significant effect ($P<0.01$) of increasing the ADF, NDF, cellulose and lignin content, except hemicellulose. A single factor of harvest age had a highly significant effect ($P<0.01$) to all-fiber fraction content in this research. The fiber fraction content rise as the harvest age increased.

In this research, the content of fiber fraction (NDF, ADF, cellulose, and lignin) rose as the harvest age increased, this correlated with the increase in the stage of plant growth. This finding is consistent with that of [36]. The result of this research is in line with ([3]; [37]; [22]), stating that the component of plants' cell walls increases as harvest age and plant growth rises.

HCN content of forage sorghum: HCN content of forage sorghums in this study is presented in Picture 1. The data showed that HCN content in forage sorghum at the age of 7-10 days was 313% -379 ppm, which was still safe for livestock.

Cyanide acid (HCN) is an anti-nutrient obtained from the result of the hydrolysis of cyanogenic glucoside compounds such as dhurrin in sorghum, that can be synthesized in the digestive tract into cyanide acid (HCN) [38]. [39], states that in sorghums, the content of dhurrin is found in the leaves. In its usage, forage sorghum in ruminants is often reported poisoning because sorghum has the potential to produce HCN. Poison occurs due to HCN substance released from glucoside bonds by an enzyme. An enzyme is produced either by plants or animals when the plants are cut or chewed by animals so HCN is released [38]. As reported by [40], in the early stage of growth, sorghum plants produce high content of HCN, which decreases along with the increasing maturity of the plant. Thus, it is important to know the HCN content of the hydroponic forage sorghums.

Table 4. Fiber fraction content of sorgum forage fodder (% DM).

		B1	B2	B3	Mean
NDF	A1	34.56±2.12	52.50±3.23	48.78±2.70	46.04±8.12^{B}
	A2	43.52±4.31	57.61±3.29	51.01±2.17	50.71±6.72^{A}
	A3	43.31±2.43	53.58±3.20	50.84±2.25	48.93±5.09^{A}
	Mean	40.88±5.08^{C}	54.63±3.80^{A}	50.21±2.44^{B}	
ADF	A1	14.47±0.546	22.18±2.62	23.54±2.16	20.46±4.40^{B}
	A2	22.13±1.80	28.67±2.18	30.07±2.69	26.95±4.14^{A}
	A3	22.55±1.88	30.29±1.63	30.29±1.23	27.71±4.05^{A}
	Mean	20.09±3.97B	27.04±4.15A	27.96±3.78A	
Cellulose	A1	12.60±0.83	17.97±3.08	19.06±1.57	16.82±3.43^{B}
	A2	19.60±1.88	23.28±2.50	24.70±2.48	22.53±3.08^{A}
	A3	20.75±3.00	24.51±1.93	24.28±1.23	23.18±2.69^{A}
	Mean	18.01±4.11^{B}	21.92±3.77^{A}	22.68±3.15^{A}	
Hemicellulose	A1	20.83±4.96	29.07±2.23	25.23±2.21	24.76±4.68
	A2	21.39±4.06	27.79±3.05	20.94±1.81	23.06±4.23
	A3	20.75±2.29	25.55±4.58	20.55±1.98	22.32±3.82
	Mean	20.99±3.65^{B}	27.36±3.58^{A}	22.24±2.87^{B}	
Lignin	A1	2.26±0.58	4.29±1.67	5.13±1.27	3.90±1.70b
	A2	2.87±0.92	5.13±1.48	6.43±0.55	4.81±1.81a
	A3	2.80±0.94	5.63±1.48	6.45±0.76	5.11±1.86a
	Mean	2.64±0.80^{C}	5.02±1.54^{B}	6.00±1.06^{A}	

Note: Means with different superscripts in uppercase and lowercase differ significantly at P<0.01 and P<0.05, respectively. A1=no nutrient solution, A2=addition nutrient solution 3 ml/l, A3= addition nutrient solution 5 ml/l, B1= 7 DAS, B2= 10 DAS, B3= 13 DAS. NDF = neutral detergent fiber, ADF = acid detergent fiber.

3.4. The effect of treatment on germination percentage of sprouts sorghum

The HCN fodder forage sorghum content in this study is shown in Figure 1. The test results show the HCN forage fodder sorghum content increases with nutrition solution addition and the harvest age. As mentioned in the literature review that the main factors responsible for HCN accumulation are plant species, tillers, and fertilizer [38]. The HCN content at 7-10 days in this study is still safe for livestock in the range 313% -379 ppm. The safe limit of HCN in green forage for livestock is 500 ppm on a dry basis, and in excess of 500 ppm in the forage sorghum is toxic to animal health [41].

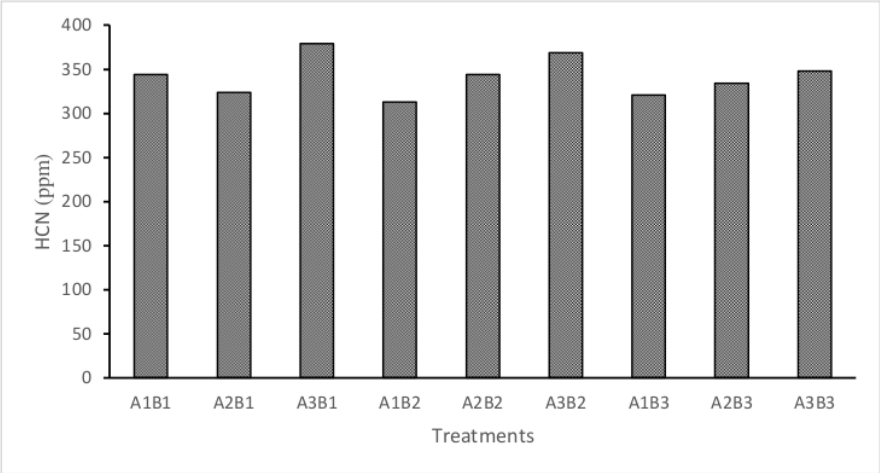

Figure 1. HCN content of sorghum forage fodder (%).

Note: A1B1 = no nutrient (7 DAS); A1B2 = no nutrient (10 DAS); A1B3 = no nutrient (13 DAS); A2B1 = nutrient 3 ml/l (7 DAS); A2B2 = nutrient 3 ml/l (10 DAS); A2B3 = nutrient 3 ml/l (13 DAS). A3B1 = nutrient 5 ml/l (7 DAS); A3B2 = nutrient 5 ml/l (10 DAS); A3B3 = nutrient 5 ml/l (13 DAS).

This increase in HCN is due to the rate of enzymatic activity during germination, which results in the conversion of cyanogenic glycosides to HCN. Several reports have shown that sorghum sprouts accumulate toxic amounts of cyanide ([42]; [43]), that in the process of germination of seeds, cyanides are protective or defense mechanism agents when the shoot is emerging.

4. Conlusion

The addition of a nutrient solution to increase growth and fresh production, the content of CF, ash, ADF, NDF, cellulose, lignin and HCN, but a decrease in the content of DM, CP, EE, and NFE. The longer the harvest age will increase growth and fresh production, the content of CF, ash, ADF, cellulose, lignin and HCN, but reduce the DM, CP, EE, and NFE.

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