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Research Article

Herbage Yield of Treated and Untreated Hydroponics Maize Fodder Using Low Cost Greenhouse Type Cultivation Unit for Livestock Production

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Abstract: The research was conducted at Duware Street within Yola South Metropolis Adamawa state, Nigeria to establish herbage and determine the yield of treated and untreated hydroponics maize fodder using low cost greenhouse type cultivation unit or devices for livestock production. The low cost greenhouses or shade net structures were prepared from thatch, wood, and polythene, tap water, the use of nutrients solution for the hydroponics fodder growth, maize grains were choosing for hydroponics fodder production. The hydroponics green fodder looks like a mat of 20-30 cm height consisting of roots, seeds and plants. The hydroponics green fodder is more palatable, digestible and nutritious to the animals. Stem length (cm) revealed no significant (P<0.05) different across the treatments ranged from (8.65 to 9.84cm) with the highest figure of (9.84cm) in T_4, followed by (8.96cm) in T_3 and the least value (8.65cm) was recorded in T_1. Plant height ranged from (30.22 to 31.69cm) which showed highly significant (P<0.01) different among the treatment means, the highest value (31.69cm) was recorded in T_4, followed by (30.77cm) in T_3, and the least figure (30.22cm) was recorded in T_1. Biomass yield (kg/a/day) showed highly significant (P<0.01) different across the treatment, ranged from (5.81 to 6.92) kg/a/day, the highest figure of (6.92kg/a/day), followed by (6.64 kg/tray/day) in T_3 and the least value (5.81 kg/a/day). Leaves length ranged from (21.57 to 21.85cm) showed no significant (P<0.05) different across the treatments group, the highest value (21.85cm) was recorded in T_4, followed by (21.81cm) in T_3 and the least figure (21.57cm) was recorded in $T_{1.}$ and Root length also showed no significant (P<0.05) different among the treatments, ranged from (12.98 to 13.98cm), the highest value (13.98cm) was recorded in T_4, followed by (13.94cm) in T_3 and the least value (12.98cm) was recorded in $T_{1.}$
Keywords: Hydroponics, Treated, Untreated, Maize Fodder, Low-cost green house, cultivating unit.

Introduction

In most parts of the world, protein is specifically the major nutrient deficiency in people's diets, an average Nigerian consumes about 5.5 g of animal protein per head/day which is by far lower than the recommended 77 g per head/day, the low level of animal protein intake in Nigeria is due to the low level of livestock productivity and high cost of animal protein FAO, (2006). Inadequate nutrition is a major limitation to livestock productivity in Nigeria and other countries within the arid and semi-arid regions of sub Saharan Africa. Production of hydroponics fodder in low cost greenhouses is an effective solution for fodder scarcity and a promising technology for sustainable livestock production in Nigeria (Naik *et al.,* 2013). Bakshi *et al.,* (2017) reported that hydroponics fodder is used in harsh climate such as deserts areas with poor soil or in urban area where high land cost has driven out traditional agriculture, hydroponics fodder is probably best suited to tropical and drought prone region of the world suffering from chronic water shortage or in areas where irrigation infrastructures does not exist. Hydroponics is a boom for farmers whose soil is rocky or infertile. It is a viable farmer's friendly alternative technology for landless farmers for fodder production, hydroponics fodder can be produced in low cost greenhouses or devices, the low cost greenhouses or shade net structures can be prepared from thatch, wood, mosquito net etc.

The cost of the shade net structures depends upon the type of fabricated material used, but the produce is significantly lower than the hi-tech greenhouses. The side fencing structure of the house can be made up of thatches which reduce the cost of fabrication. The irrigation can be made by micro-sprinklers (manually using knapsack sprayer).

In shade net structures, the type of cereals to sprout hydroponically depends upon the season and climatic conditions of the locality (Naik *et al.,* 2013). Feeding livestock with hydroponics maize fodder as a partial feed substitute on protein basis at 30 percent level maintains the growth performance effectively without compromising the growth performance as described by Shyama *et al.*, (2016).

Material and Methods

Study Area

The research was conducted at the Duware Street, within Yola South Local Government Area Metropolis, with an area of 718km^2. The Local Government is bounded to the North by Yola North, and Girei to the East, Fufore to the South and Demsa to the West Local Government areas of Adamawa State. Adamawa State is located between latitude 7°N 11°N of the equator and between Longitude 11^0 and 14^{0}E of the Greenwich Meridian as described by Anthony, (2014).Temperatures ranged from 18^{0}C to 44 ^{0}C, according to Adebayo and Tukur, (1999). The total land area covered by the state is approximately 39,742.13km^2, bounded to the North by Borno State, west by Gombe State, to the south by Taraba State and east by the Republic of Cameroon. Adamawa State has some of the longest mountain ranges and breath, taking landscape sceneries in the country with areas as low as about 129 meters and as high as 2042 meters above sea level.

Experimental procedure

Sources and storage of maize seeds

White maize (*Zea mays*) grains were procured from Yola South Local Market of Adamawa State. The grains were subjected to seeds selection and seeds treatment to check their viability before use as described by Badran *et al.,* (2017). Seeds were sun dried a day prior to seeds washing; broken seeds and foreign materials were removed and seeds were stored in a dry and safe place.

Washing and removal of chaff from the seeds

White maize seeds of four kilograms were properly washed with 10-12 liters of water by scrubbing using stick; the seeds settled down after 5 minutes**,** light and floated seeds on top of the water were removed, grains were stirred manually using wooden stick, the water was then drained completely, this process was repeated till broken and dead seeds were removed completely as described by Rachel *et al.,* (2015).

Treatments of seeds and improvised silver aluminum trays

White maize grains of 4kg were treated or sterilized with one liter of sodium hypochlorite solution (domestic hypo) diluted with 4 to 5 liters of clean water, 100mls of the concentrated solution was collected and used to provide the concentration needed for sanitizing the seeds as revealed by Rachel *et al.,* (2015). The seeds were washed thoroughly after treatments for 30 minutes using 10-12 liters of clean water to remove the residue of concentrated hypochlorite solution. Planting trays were washed with diluted hypochlorite solution and disinfected before and after harvest as reported by Fazaeli *et al.,* (2012).

Soaking of maize seeds

Clean water was measured using TDS instruments and pocket pH meter before use, four kilogram of maize grains were weighed using weighing scale; the grains were soaked and submerged completely in clean water of 7 to 8 liters using 10 liters calibrated rubber bucket; the seeds remained for a period of 12 hours, 12 hours later the water was drain and collected to measure the total dissolved solid using TDS meter against infestation as reported by Shyama *et al.*, (2016).

Incubation period of maize seeds

After soaking the seeds for 12 hours, the wet seeds were transferred directly into clean dry fumigated jute bags, the seeds remained inside the bags for a period of 24 hours (incubation). The bags were kept away from direct sunlight to avoid sun drying of the seeds, 8 to 10 liters of clean water was sprinkled after every 2-3 hours on the seeds to wet as revealed by Rachel *et al.*, (2015).

Planting of maize seeds

24 hours after incubation period, germinated seeds (sprouted seeds) were transferred immediately to clean improvised silver aluminum trays, perforated to drain out excess amount of water during irrigation. The drained water was collected with the aid of a calibrated rubber container to measure the total dissolved solids of nutrients solution of $Ca(NO_3)_2$ and NPK fertilizer after irrigation using TDS (total dissolved solid) meter as reported by Naik *et al.*, (2016).

Seeds rate

The recommended seeds rate are 3cm/tray high for proper sprouting/germination of hydroponics fodder which were consistent with 3.5cm/tray as described by Nail *et al.*, (2015); high density may results to more chances of microbial contamination in the roots mat which affects the growth of the sprouted maize seeds.

Preparation of calcium nitrates ($Ca (NO_3)_2$)

A solution of Calcium nitrates was prepared by adding 100g of solid $Ca(NO_3)_2$ in 1 liter of water and the substance dissolved after 2 minutes by stirring the solution, 1 to 3mls of $Ca(NO_3)_2$ solution was collected and added into 2 liters of water and was applied 2 times using knapsack sprayer to growing biomass of hydroponics maize fodder. T_1 = no fertilizer, T_2= 1ml of $Ca(NO_3)_2$solution was collected and added into 2litres of water plus 0.6ml NPK, T_3 = 2mls of $Ca(NO_3)_2$ solution was collected and added into 2litres of water plus 0.4ml NPK and T_4 = 3mls of $Ca(NO_3)_2$solutionwas collected and added into 2litres of water plus 0.2ml NPK

Management of hydroponics maize fodder

Fresh water was sprayed after sprouting for the first five (5) days while solution of NPK and calcium nitrates $Ca(NO_3)_2$ was sprayed on day 6th with (0.6ml of NPK +1ml of Ca $(NO_3)_2$ 0.4ml of NPK + 2ml Ca $(NO_3)_2$ (on day 7th) and 0.2ml of NPK+ 3ml $Ca(NO_3)_2$ (on day 8th) using knapsack sprayer to spread evenly on each surface of sprouted maize, and it was kept moist, not dried or flooded as reported by (Naik *et al.*, 2014). And the solution was withdrawn on day 8th prior to harvest (on day 9th).

The maize fodder on the perforated trays were irrigated manually with hydroponics nutrients solution twice a day (07:30 and 17:30 hr.) at a fixed rate of 300 ml/tray/day using knapsack sprayer for 15minutes. Drained water was collected and measured the total dissolved solid of calcium nitrate Ca $(NO_3)_2$ and NPK fertilizer solution using TDS meter against infestation as reported by Bakshi *et al.*, (2017).

Harvesting of hydroponics maize fodder

The whole plants were harvested on day 9th after planting (Treated and untreated hydroponics maize fodder); samples of the green fodder were taken on weekly basis, dry matter and other nutrients contents were determined. The quantity of hydroponics maize fodder and biomass production was recorded daily by weighing the seeds before planting and weighing the fodder after harvest. The following parameters were determined; plant height (cm), leaves length (cm), stems length (cm), roots length (cm) and biomass yield (kg/a/day) from day 1 to 9th.

Biomass Production: Analysis of biomass production was taken for each tray throughout the experiment for the period of 90 days.

Parameters of Herbage yield

The following parameters were determined; Stem length (cm), Plant height (cm), Leaves length (cm), Biomass yield (kg/a/day), Roots length (cm) from 2 to 9th day.

Procedure to determine the herbage yield of hydroponics maize fodder

Plant height from 2 to 9th days

Plants heights were measured according to Desalegn, (2007) procedure. It was measured using 30cm plastic ruler; the base of the plants to the longest leaf was measured. A method of Rahma *et al.*, (2016) was used where plants height were measured from its base to where the last leaf on the stem emerges using a plastic ruler; it was done by randomly selecting five (5) culms (stem) per tray before each harvest, similarly plants height was measured by looking at the primary shoot surface to the base of the most leaf using plastic ruler as described by Susan *et al.,* (2016).

Leaves length per plants (cm) from 2 to 9th days

Leaves length were measured according to Desalegn, (2017) procedure, it was measured from the tips of the leaf to the ligules of a maize fodder using 30cm plastic ruler, the leaves were randomly selected on five (5) culms (stem) from each tray.

Roots Length (cm) from 2 to 9th day

It was measured from the tip of the roots to the base of the roots as reported by Rahma *et al.*, (2016) using plastic ruler. The roots were randomly selected on five (5) culms (stem) from each tray.

Biomass Yield (kg/a/day)

The quantity of hydroponics maize seeds and biomass production was recorded daily by weighing the quantity of seeds before planting and weighing after the fodder was harvested as reported by Naik *et al.*, (2014).

Stem length (cm) from 2 to 9th day

It was measured from the base of the roots to the axial of the leaf as reported by Desalegn, (2017). The stem lengths were randomly selected on five (5) culms (stem) from each tray.

Chemical analysis

Samples of feeds were collected and chemically analyzed using the proximate analysis Procedure (AOAC, 2004).

Results

Table 1. Herbage Yield of Treated and Untreated Hydroponics Maize Fodder with NPK and $Ca(NO_3)_2$

Parameters	T_1 UHMF	T_2 THMF	T_3 THMF	T_4 THMF	SEM	
Stem length (cm)	8.65^a	8.93^a	8.96^a	9.84^a	0.33	0.11^{ns}
Plant height (cm)	30.22^c	30.73^a	30.77^b	31.69^d	0.33	0.11**
Biomass yield (kg/a/ day)	5.81^a	6.20^b	6.64^c	6.92^d	0.33	0.11**
Leaf length (cm)	21.57^a	21.80^a	21.8^a	21.85^a	0.33	0.11^{ns}
Root length (cm)	12.98^a	13.78^a	13.94^a	13.98^a	0.33	0.11^{ns}

Key:
UHMF = Untreated hydroponics maize fodder = T_1,
THMF = Treated hydroponics maize fodder at graded levels T_2 = 0.6ml NPK +1ml Ca $(NO_3)_2$,
T_3 = 0.4ml NPK +2ml Ca $(NO_3)_2$,
T_4 = 0.2ml NPK +3ml Ca (NO_3),
Mean within same row bearing different superscript differ significantly (P<0.05) *,
(P <0.01) **, (P <0.001) ** SEM = Standard Error Mean,
LSD = Least significant different,
ns = No Significant Different, treated with nutrients solution of NPK and Calcium Nitrate at graded levels

T_1 = Treatment one (untreated HMF raised on water only)

T_2 = Treatment two (treated with nutrients solution at 0.6mlnpk +1ml Ca $(N0_3)_2$

T_3 = Treatment three (treated with nutrients solution at 0.4mlnpk +2ml Ca$(N0_3)_2$

T_4 = Treatment four (treated with nutrients solution at 0.2mlnpk +3ml Ca$(N0_3)_2$

Table 1 showed the effects of graded levels of nutrients solution of NPK and calcium nitrate Ca $(NO_3)_2$ solution on growth and biomass yield of treated and untreated hydroponics maize fodder. Stem length (cm) revealed no significant (P<0.05) different across the treatments ranged from (8.65 to 9.84cm) with the highest figure (9.84cm) in T_4, followed by (8.96cm) in T_3 and the least value (8.65cm) was recorded in T_1.

Plants height ranged from (30.22 to 31.69cm) showed highly significant (P<0.01) different among the treatment means, the highest value (31.69cm) was recorded in T_4, followed by (30.77cm) in T_3, and the least figure (30.22cm) was recorded in T_1.

Biomass yield (kg/a/day) showed highly significant (P<0.01) different across the treatment ranged from (5.81 to 6.92) kg/a/day, the highest figure (6.92kg/tray/day), followed by (6.64 kg/tray/day) in T_3 and the least value (5.81 kg/tray/day). Leave length (cm) ranged from (21.57 to 21.85cm) showed no significant (P<0.05) different across the treatments groups, the highest value (21.85cm) was recorded in T_4, followed by (21.81cm) in T_3 and the least figure (21.57cm) was recorded in T_1 and Roots length (cm) also showed no significant (P<0.05) different among the treatments ranged from (12.98 to 13.98cm), the highest value (13.98cm) was recorded in T_4, followed by (13.94cm) in T_3 and the least value (12.98cm) was recorded in T_1.

Table 2. Nutrients contents (% DM basis) of untreated hydroponics maize fodder

N %	0 day	Days of sprouting under hydroponics system								
	DMS	1	2	3	4	5	6	7	8	9
CP %	8.60	8.88	9.14	9.65	11.27	11.58	12.89	13.57	13.63	13.73
CF %	2.50	2.55	3.07	4.72	5.51	7.56	10.62	14.07	14.12	14.43
EE %	2.56	2.49	2.57	2.88	3.08	3.06	3.21	3.49	3.50	3.51
Ash %	1.57	1.67	1.84	1.92	2.19	2.44	3.34	3.84	3.85	3.87
NFE %	84.77	84.39	83.38	80.83	77.95	75.36	69.89	65.03	64.90	64.46
AIA %	0.02	0.03	0.08	0.09	0.13	0.14	0.24	0.33	0.34	0.36
ME Kcal kg	3,534.89	3,527.17	3,506.34	3,459.79	3,433.69	3,415.24	3,233.95	3,096.68	3,091.76	3,080.65
NFE =100 – (%CP + % CF + % EE + %ASH), Metabolizable Energy = ME (Kcal/kg) = 37 x %CP + 81 x %EE + 35.5 X %NFE										

Table 3. Nutrient contents (% DM basis) of treated hydroponic maize fodder

Nutrient %	Mize Seed (0 Day)	Untreated HMF (Day 5)	Treated HMF 0.6ml lNPK+1ml $Ca(N0_3)_2$ (Day 6)	Treated HMF 0.4ml NPK+2ml $Ca(N0_3)_2$ (Day 7)	Treated HMF 0.2ml NPK+3ml $Ca(N0_3)_2$ (Day 8)	Harvested HMF (Day 9)
Moisture	4.93	81.80	81.60	81.44	81.27	81.25
Dry Matter (DM)	95.07	18.20	18.40	18.56	18.73	18.75
Crude Protein (CP)	8.60	11.58	13.34	13.66	13.73	14.53
Crude Fibre (CF)	2.50	7.56	10.67	14.07	14.82	14.89
Ether Extract (EE)	2.56	3.06	3.21	3.49	3.51	3.54
Total Ash (TA)	1.57	2.44	3.34	3.84	3.89	3.94
Nitrogen free Extract (NFE)	84.77	75.36	69.44	64.94	64.05	63.10
Neutral Detergent Fibre (NDF)	75.36	55.15	69.89	65.03	63.83	63.10
Acid Insoluble Ash (AIA)	0.02	0.14	0.24	0.33	0.35	0.38
ME (Kcal/Kg)	3,534.89	3,415,24	3,218.71	3,093.48	3,066.09	3,064.40
Metabolizable Energy = ME (Kcal/kg) = 37 x %CP + 81 x %EE + 35.5 x NFE, %NFE = % DM – (% EE + % CP + % ASH+ % CF), HMF = Treated and untreated hydroponics maize fodder, Calcium nitrate solution ($Ca(NO_3)_2$) and Nitrogen, Phosphorus and Potassium solution (NPK)						

Key: UMS. Untreated maize seeds. TMS, Treated maize seeds
Metabolizable Energy = ME (Kcal/kg) = 37 x %CP + 81 x %EE + 35.5 x NFE, NFE = 100– (% CP + % CF + % EE + ASH), HMF = Treated and untreated hydroponics maize fodder, $Ca(NO_3)_2$ = Calcium nitrate solution and NPK = Nitrogen, Phosphorus and Potassium solution.

Maize seeds soaked with untreated water
T_1 = Treatment one (maize seeds soaked with untreated water for 12 hours)

T_2 = Treatment two (maize seeds soaked with untreated water for 12 hours)

T_3 = Treatment three (maize seeds soaked with untreated water for 12 hours)

T_4 = Treatment four (maize seeds soaked with untreated water for 12 hours)

Nutrients content (% DM basis) of treated, untreated hydroponics maize fodder, untreated sorghum chaff and maize offal.

The crude protein (CP) contents of treated maize seeds (8.60%), followed by untreated sorghum chaff value (6.26%) and maize offal contains (11.62%). The crude protein of treated hydroponics maize fodder ranged from 13.34 day 6thto 14.53% day 9thfollowed by 13.73% day 8th and the least value 13.34% was recorded in day 6th while the untreated hydroponics maize fodder ranged from 8.88 to 13.73% day 1st to 9thfollowed by 13.63% day 8th and the least value 8.88% was recorded in day1st. Dry matter of treated hydroponics maize fodder ranged from (18.40) day 6th to (18.73%) day 9th, the highest dry matter value (18.73%) was recorded in day 9th, followed by (18.73%) day 8th and the least value (18.40%) was recorded in day1st, dry matter of 96.0% was recorded for Maize offal and 85.00% for untreated sorghum chaff.

Crude fiber of untreated hydroponics maize fodder ranged from 2.55% day 1 to 14.3% day 9th, the highest value (14.3%) was recorded in day 9th, followed by (14.12%) day 8th and the least value (2.55%) was recorded in day 1 while the treated ranged (10.67%) day 6th and (14.89%) day 9th. The highest value (14.89%) was recorded in day 9^{th} followed by (14.82%) day 8^{th} and the least value (10.67%) was recorded in T_1. Maize offal contains crude fiber of (12.85%) while untreated sorghum chaff has (30.15%).

Ether extract of treated hydroponics maize fodder ranged (3.21%) day 6^{th} to 3.54% day 9^{th}, the highest value (3.54%) was recorded in day 9^{th}, followed by (3.51%) day 8^{th} and the least value 3.21% was recorded in T_1 while the untreated ranged from (2.49%) day 1 to (3.51%) day 9^{th}, the highest value (3.51%) was recorded in day 9^{th}, followed by (3.50%) day 8^{th} and the least value (2.49%) was recorded in day 1. Maize offal contains ether extract of (1.42%) while untreated sorghum chaff has (2.50%).

Total Ash ranged from (3.21%) day 6^{th} to (3.54%) day 9^{th}, followed by (3.51%) day 8^{th} and the least value 3.21% was recorded in T_1 while the untreated hydroponics ranged from 1.67%) day 1 to (3.94%) day 9^{th}, the highest value (3.94%) was recorded in day 9^{th}, followed by (3.89%) day 8^{th} and the least value (1.67%) was recorded in day 1. Maize offal contains total ash of (5.0%) while untreated sorghum chaff has (3.72%).

Nitrogen Free Extract (NFE) of treated hydroponics maize fodder ranged from (69.49%) day 6^{th} to (63.10) day 9^{th}, the highest value 69.49% was recorded in day 6^{th}, followed by (64.94%) day 7^{th} and the least value (63.10%) was recorded in day 9^{th} while the untreated hydroponics maize fodder ranged from (84.42%) day 1 to (64.46%) day 9^{th}, the highest value (84.42%) was recorded in day 1, followed by (83.38%) day 2^{nd} and the least value (63.03%) was recorded in day 7^{th}. Maize offal contains crude fiber of (40.24%) while untreated sorghum chaff has (49.63%).

Acid Insoluble ash (%) of treated hydroponics maize fodder ranged from (0.24) day 6^{th} to (0.38%) day 9^{th}, the highest value (0.38%) was recorded in day 9^{th}, followed by (0.35%) day 8^{th} and the least value (0.24%) was recorded in day $6^{th.}$ while untreated hydroponics maize fodder ranged from (0.03%) day 1to (0.36%) day 9^{th}, the highest value (0.36%) was recorded in day 9^{th}, followed by (0.34%) day 8^{th} and the least value (0.03) was recorded in day 1.

The metabolizable energy (ME Kcal/kg) of treated hydroponics maize fodder ranged from 3,064.40 to 3,218.68 ME kcal/kg, the highest value 3,218.68 kcal/kg was recorded in day 6^{th}, followed by 3,091.26 kcal/kg recorded in day 7^{th} and the least value 3,064.40 kcal/kg recorded in day 9^{th} while untreated hydroponics maize fodder ranged from 3,527.16 kcal/kg day 1 to 3,064.41 kcal/kg day 9^{th}, the highest value 3,527.16 kg/cal was recorded in day 1, followed by 3,506.34 kcal/kg day 2^{nd} and the least value 3,058.29 kcal/kg was recorded in day 8^{th}.

Discussion

Plant height (cm): The data recorded on plants height was presented in table 1. The data revealed that the highest height of the plants after the end of the 9^{th} day was recorded in T_3 group (30.77cm) followed by T_2 (30.73cm), T_4 (31.69 cm) and the least value (30.22cm) was recorded in T_1. The differences ($P<0.01$) among the treatment in respect of plants height was found to be significant, the highest plants height of 31.65cm was recorded in T_4 group treated with (0.2ml NPK and 3ml $Ca(NO_3)_2$, could have been attributed to the optimum contents of nitrogen which stimulates the vegetative growth of the plants, it was also observed that there was a decline in plants height with the gradual increased in the concentration of NPK and calcium nitrate solution Nur *et al.*, (2014). The results (30.22 to 31.65cm) of the present study are in close findings of Deivis *et al.*, (2016) who reported that an increase of the vegetative growth (height of the plants) was more pronounced in treatments that used synthetic nutrients solution.

Root length (cm): The data on roots length of the maize plants was presented in table 1. The data recorded revealed that the highest roots length after the end of the 9^{th} day was recoded in T_4 (13.98cm), followed by T_3 (13.94cm), T_2 (13.78cm) and the least value T_1 (12.98 cm). The differences (P< 0.01) among the treatment were significant, the highest roots length of 13.98cm was observed in T_4 group, and the least value (12.98%) was obtained in T_1 this could be attributed to lack of nutrients solution to the plants Nur *et al.,* (2014). It was further observed that there was a gradual decrease in roots length with the enhancement of NPK and calcium nitrate which has detrimental effects on roots development as reported by Mutum and Surve, (2017).

Biomass yield (kg/a/day): The data (5.81 to 6.90 cm) was presented in table 1. The data recorded on the biomass yield of the hydroponics maize fodder for the entire experimental period presented in table 3 were significantly (P<0.01) different. The data recorded revealed that the highest biomass yield was observed in T_4 (6.92kg) and was highly significant (P<0.01) superior than the fodder yield obtained in T_1 (5.81kg), T_2 (6.20kg), and T_3 (6.64kg) this could be attributed to lack of nutrients solution to the plants. The highest biomass yield of (6.92kg) noticed in treatment T_4 could be attributed to the higher nutrients solution of NPK and calcium nitrate solution on growth assimilate which in turn increased plant metabolism resulting in tissue development, dry matter accumulation and the biomass yield increase. The present findings are in conformity with Mutum and Surve, (2017) who reported a maximum yield of 7.82kg.

Leaf length (cm): The result (21.57 to 21.85cm) recorded was presented in table 1. The data revealed the highest leaf length of the maize plants at the end of 9^{th} day was recorded (21.85cm) in treatment T_4, followed by T_3 (21.80cm), T_2 (21.80cm) and the least value (21.57cm) was recorded in $T_{1.}$ There was no significant (P<0.05) different across the treatment for the recorded value 21.57 to 21.85cm. The highest leaf length of 21.85cm could be attributed to the optimum contents of NPK and calcium nitrate solutions which stimulate the vegetative growth of the plants. It was observed that there was decreased in leaf length with gradual increase in the concentration of NPK and calcium nitrate solution from day 8^{th}. The results (21.57 to 21.85cm) of this study agreed with the findings of Devis *et al.,* (2016) who reported increased in NPK and calcium nitrate solutions which could be attributed to change of environmental conditions like temperature, light and relative humidity Nur *et al.,* (2014).

Stem length (cm): The data recorded on stem length were presented in Table 1. The value (8.65 to 9.84 cm) revealed that the highest stem length at end of the 9^{th} day germination was recorded in T_4 (9.84cm), followed by T_3 (8.86cm), T_2 (8.93cm) and the least value (8.65cm) in T_1. The highest stem length value (9.84cm) recorded in this study could be attributed to the optimum inclusion levels of calcium nitrate $Ca(NO_3)_2$ and decreased in NPK solutions. The values (8.65 to 9, 84 cm) were higher than the figure (8.42 to 9.04 cm) as reported by Mutum and Surve, (2017). The higher figure could be attributed to the change of environmental conditions which affect the greenhouse condition.

Nutrients content (% DM Basis) of treated: Untreated hydroponics maize fodder, untreated sorghum chaff and maize offal was presented in table 2 and 3.

Dry matter: The proximate compositions of treated hydroponics maize fodder contained dry matter ranged from (81.60%) day 6^{th} to (18.25%) day 9^{th}, the lower dry matter (DM) of treated maize hydroponics maize fodder may be due to large uptake of water which initiates increasing metabolic activity of resting seeds that leads to complete loss of dry weight (starch) during germinating cycle of hydroponics fodder (Morsy *et al.,* 2013) whereas the % DM of maize seeds (95.07%) was higher than treated hydroponics maize fodder (18.60%) day 9^{th} which may be due to the increased in photosynthetic activity and increased stage of maturity which leads to higher biomass production. The increased in fresh weight and decreased in dry matter (DM) content during sprouting of seeds could also be due to the inhibition of water and enzymatic activities Naik *et al.,* (2016). The inhibition of water and enzymatic activities deplete or reduce the food reserve of the seeds endosperm without any adequate replenishing from photosynthesis by the young plants which provide little change for dry matter (DM) accumulation during short growing cycle (Sneath and Mclintosh, 2003).

Crude protein: The crude protein (CP) content of the maize seeds was 8.60%, which remained similar up to 2nd day. (9.14%) of growth in hydroponics system. The crude protein (CP) contents of treated and untreated hydroponics maize fodder sprouted maize showed an increasing trend with germination time and remained highest on 9th day (14.53% and 13.73%) of growth. The increase in protein content may be attributed to the loss in dry weight particularly carbohydrates, through respiration during germination, while longer sprouting time was responsible for the greater losses in dry weight and increasing trend in protein contents (Gupta *et al.,* 2004). Up to 3rd day (9.65%) growth of the hydroponics fodder maize, crude protein (CP) contents was lower than crude protein (CP) contents (10.67%) of fodder maize harvested at about 60 days under conventional practices as reported by Naik *et al.,* (2012); but from 4th day onwards, values of the former remained higher than the later.

Ether extract: The ether extract (EE) of maize seeds was 2.56% and remained similar up to 5th day growth (3.06%) of untreated hydroponics maize fodder and was similar to maize fodder (2.27%) grown under conventional practices and harvested at about 60 days as reported by Naik *et al.,* (2015). The ether extract (EE) content of treated hydroponics maize fodder on 9th day (3.54%) was the highest among fodder maize at different stages of growth under hydroponics system and conventional practices, which might be due to the high chlorophyll contents at that particular stage, which was extracted completely and determined as ether extract (EE). The ether extract contents of untreated hydroponics maize fodder on 7th day (3.49%) agreed with the finding of Naik *et al.,* (2013) who reported (3.27 to 3.50%). The ether extract (EE) 2.50% of untreated sorghum chaff was lower than the value 5.90% as reported by Ashiru *et al.,* (2013). The ether extract (EE) of maize offal 1.42% was consistent with 1.40% as reported by Abdullahi *et al.,* (2016) who fed urea treated sorghum chaff as a basal diets supplemented with maize offal's to Yankasa rams.

Crude fiber: The crude fiber (CF) contents of hydroponics maize fodder seeds was 2.50% and increased up to 14.43% on day 9th of growth but was lower than the fodder maize grown under conventional practices (25.92%) as reported by (Singh *et al.,* 2009; Singh *et al*., 2011). The increase in crude fiber (CF) contents during sprouting of maize might be due to the synthesis of structural carbohydrates such as cellulose and hemicelluloses, however, the crude fiber contents on 9th day treated hydroponics maize fodder was (14.89%); this could also be due to the buildup of varied proportion of hemicelluloses and lignin as reported by Weldegerima (2017). Maturity impresses the crude fiber contents of hydroponic maize fodder; the matured stem portion of conventional maize fodder contained more crude fiber than the soft portion (skin and leaves) of the hydroponics maize fodder as reported by Naik *et al.,* (2012). The crude fiber (CF) of untreated sorghum chaff was 30.15% lower than the value 35.60% as reported by Abdullahi *et al.,* (2016) who fed urea treated sorghum chaff as a basal diets supplemented with maize offal's to Yankasa rams. The crude fiber (CF) contents of maize offal was 12.85% higher than the value 11.85% as reported by Alikwe *et al.,* (2012) who fed maize bran, wheat offal and rice bran to West African Dwarf goats.

Total ash: The total ash (TA) value 3.94% at 9th day growth period of treated hydroponics maize fodder was higher than in seeds form (1.57%); the above value (3.94%) manifested was found higher with increased maturity of the conventional maize fodder (9.36%) as reported by Morsy *et al.,* (2013), however, the recorded value (3.94%) was lower than the figure 9.36% in conventional maize fodder at 60 days growth period as reported by Naik *et al.,* (2016). The total ash (TA) contents 3.72% of untreated sorghum chaff was lower than the value 7.85% as reported by Ashiru *et al.,* (2013). The recorded value of maize offal 5.0% was higher than the value 3.69% as reported by Babale *et al.,* (2018) who fed Maize Cob Replacing Maize Bran with Cowpea Husk Basal Diet to Sokoto red Goat.

Acid insoluble Ash: Acid Insoluble Ash (AIA) of treated hydroponics maize fodder was found 0.38% at 9th day of growth which was higher than the value 0.02% in seeds form as reported by (Sneath and McIintosh, 2003). Similarly, the value 0.38% was higher than the figure 0.33% as reported by Mounshwari *et al.*, (2019) that produce maize fodder under low cost system of production.

Recommendations

The following recommendations were made from the study:

a) There are needs for farmers' awareness on hydroponics fodder production, because it's more economical than conventional in terms of space and unit cost of production.
b) Suitable locally available materials should be sourced and used for constructing hydroponics system and this will go a long way in reducing the cost of production.
c) Enlightenment and training of farmers on hydroponics fodder production should be carried out by skilled personnel.
d) Farmers are advised to form cooperative societies to access market for their produce, training and farm inputs.
e) Government should provide easy access to agricultural grants at subsidies or low interest credit facilities to farmers as hydroponics production generate employment along the entire livestock value chain.

Conflicts of interest

The authors declare no conflicts of interest.

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