OPEN ACCESS

Check for updates

AGRICULTURE ARCHIVES

Original Research Article

ISSN: 3041-5322

Journal homepage: agriculture.researchfloor.org

Effects of Water Harvesting Techniques and Supplementary Irrigation treatment on five tree fodder species saplings growth and survival in the Field

Salih Omer Tutu[1], **Muneer Elyas Siddig Eltahir***[2], **Ali A. H**[1], **and Adam M. A. E**[1]

[1]Department of Forestry and Range Sciences, Faculty of Natural Resources and Environmental Studies, University of Kordofan, 51111 El Obied, Sudan

[2]Instituite of Gum Arabic Research and Desertification Studies, University of Kordofan, 51111 El Obied, Sudan

ABSTRACT

This experiment was carried out at the Agricultural Research Farm in Wad elbaga in Sheikan locality, North Kordofan State, to evaluate the effects application of water catchment and supplementary irrigation on the establishment and growth of five fodder species: Acacia seyal (Telh), Acacia senegal (Hashab), Acacia mellifera (Kiter), Faidherbia albida (Haraz) and Acacia tortilis (Sayal). A completely randomised design was conducted using five tree species, three treatments of water harvesting plus supplementary irrigation, control with irrigation and control without irrigation in three replicates. Readings were taken in summer and autumn for two years, 2016 and 2017, and saplings' characteristics of diameter, height and the number of branches were measured. SAS statistical software was used for analysis of variances and Duncan multiple ranges for means comparison. The results of the experiment showed there were variations in survival rate between species in which water harvesting and supplementary irrigation treatments showed better high 100% survival rate in Acacia mellifera, Acacia senegal and Acacia tortilis saplings in the field followed by control with irrigation treatment showed 66.7% survival rate for Acacia mellifera and 55.6% for Acacia senegal but in control without irrigation all saplings were dead. Moreover, the results of the study also showed significant differences with the best results in Acacia mellifera 100% and Acacia senegal 92.6% survival rate in autumn seasons 2016, while it decreased in Acacia senegal 66.7% and Acacia mellifera 63% in summer season 2017. Also, the results showed significant differences (P=0.05) in mean sapling diameter 0.394mm and number of branches means 1.296 of Acacia senegal sapling in season 2017, while no significant differences were found in sapling height 0.405mm of Acacia senegal in summer season 2016. The study revealed that there were positive effects of water catchment and supplementary irrigation treatments on fodder tree sapling growth performance in the field. Therefore, the study recommended using water harvesting techniques and supplementary irrigation in plantation establishments.

Keywords: *Water harvest, acacia senegal, supplementary irrigation, survival, growth, fodder.*

1. Introduction

Agricultural water management contains wider practices, including in situ moisture conservation, water harvesting, rainwater harvesting, supplementary irrigation, various techniques of wetland development such as treadle pumps, drip irrigation systems and sprinkler systems [1]. More recently, the increasing focus on good practices on water development and used especially in dry lands, which is recognised as centred on investments in agriculture development, mining, tourism and urban extension. Demonstration progress has been made in Ethiopia, Kenya, and Uganda in putting in place a conducive policy and institutional framework for water development and management in which integrated approaches supported by decentralised and participatory institutions are currently in place, and at various stages of development [2]. Also, understanding the forest-water nexus, as the latest phase of the development, was considered in the FAO Forest-Water Monitoring Framework [3]. However, water harvesting is an ancient technique that has been used for thousands of years in most of the dry lands of the world. For example, as reported by [4] water harvesting, is defined as the collection of runoff and its use for the irrigation of crops, pastures and trees, and for livestock consumption, comprises six different forms, primarily defined by the ratio between collecting and receiving area were included: rooftop water harvesting, water harvesting for animal consumption, inter-row water harvesting, micro-catchment water harvesting, medium-sized catchment water harvesting and large catchment water harvesting. Some water harvesting methods, such as subsistence mortar used to support the renewal of feed, grass, and trees and in the form of terraces in Kenya [5]. While the best practices in water harvesting in Sudan include bunds or terraces, ridges, tied ridges, sayreen, micro-catchments, small dams, baobab trees and *hafirs* [6]. Supplemental irrigation (SI) is defined as the addition of limited amounts of water to essentially rain-fed crops, in order to improve and stabilise yields during times when rainfall fails to provide sufficient moisture for normal plant growth [5]. Supplementary irrigation is of great importance in stopping land degradation and stabilising dunes. Although in the dry areas with a limited amount of water applied, especially during the critical crop growth stages, supplementary irrigation is essential to improve yield and water productivity [5].

Citation: Salih Omer Tutu, Muneer Elyas Siddig Eltahir, Ali A. H, and Adam M. A. E (2026). Effects of Water Harvesting Techniques and Supplementary Irrigation treatment on five tree fodder species saplings growth and survival in the Field. *Agriculture Archives: an International Journal.*
DOI: https://doi.org/10.51470/AGRI.2026.5.1.01

Received on: November 02, 2025
Revised on: December 05, 2025
Accepted on: January 03, 2026

Corresponding author: **Muneer Elyas Siddig Eltahir**
E-mail: **muneersiddig88@gmail.com**

Therefore, water harvesting and supplemental irrigation are essential for improved water productivity of dry farming systems, especially fodder production in West Asia and North Africa [7].

Fodder is produced from harvesting trees and shrub plants, including fruits and twigs and leaves, and flowers can benefit livestock in dry seasons, especially for nomads' pastoralist grazing systems. The main important fodder sources include forests, which provide about 20-30%) of fodder for livestock grazed on grass and weeds within the reserved and non-reserved forests, while grazing is the consumption of native forage from rangelands or pastures by livestock or wildlife.

There are some problems facing the pastoral systems. Firstly, most of the herders of livestock were present in the same climatic seasons in arid areas, which means their dependence on various natural resources. Secondly, the communal grazing system becomes administratively complicated as well as lack of coordination between pastoralists and land users due to high illiteracy rate among most users of the professional grazing system. The importance of dealing with trees by pastoral was adding significant value to the pastoral system, but is most parts of the natural grassland and forestlands are needed management process [9].

Integrated livestock in Agro-forestry systems were found to have the potential to promote climate change resilience in many countries in Africa e.g. in east Africa, agro-forestry and livestock-keeping have the potential to promote anthropogenic climate change resilience, including the planting of legume tree fodders in most parts of the region to adopt and mitigate opportunities for increasing productivity and resilience through diversification, genetic improvement, improved farm-input delivery and better management and modelling [11].

Rangelands rehabilitation process was carried out using many techniques for rehabilitation of degraded rangeland, including seeding methods, soil moisture conservation, water harvesting, water spreading etc.), in which most are rather costly compared to the likely economic returns; unless sound management is applied and controlled grazing is undertaken, then rehabilitation efforts may not be sustainable. Particularly important are clear land tenure arrangements that will motivate the beneficiaries to utilise rehabilitated sites in a sustainable manner [8].

In addition to that, integrating forage crops into farming systems for fodder crop production and the establishment of improved pastures in the cropping sequence as initiated by the Agricultural Research Corporation Forage Resources Program, by WSARP and earlier by RPA in the mechanised farming areas and irrigated, traditional dry land and mechanised farming areas as well. They were made more coordinated efforts to utilized native and introduced fodder and multi-purpose trees and shrubs within farming areas and in rangelands to provide dry season feed and supplement the dry grass with nutrition browse and pods such as the efforts of the Community-Based Rangeland Rehabilitation for Carbon sequestration and Biodiversity Project, to produce and distribute seedlings of *A. senegal*, *Faidherbia albida* and *Ziziphus spina-christi* to be used in establishing windbreaks, rangeland rehabilitation, sand dune fixation, as shade trees and in agro-forestry systems, should be expanded to other zones [8].Trees are considered as the main forage sources in arid and semi-arid regions, especially for camels, because they are less vulnerable to changes in rainfall due to the presence of the root systems at great depths.

It was reported the importance of *Acacia seyal*, *Faidherbia albida* and *Acacia mellifera* trees in many areas of Africa where the herders depended on these trees as fodder for their animals that browse leaves and pods, twigs [9]. *Acacia senegal* is also considered one of the important forage sources in Sudan, it is characterised by a medium height that makes most of its parts available for animal grazing. Although the *Aacia mellifera* tree is considered an important tree in *Mkharif*, especially *Elboutana* areas in central Sudan, where large amounts of fodder resources were found [9].

North Kordofan state belongs to semi-desert zones characterised by rainfall less than 300 mm annum and low rainfall zones with rainfall between 300 – 800 mm annum. In semi-desert zones, the major agricultural enterprise's practices were rain-fed traditional farming systems on the "*Qoz*" sand (mainly millet) and the production of gum Arabic from *Acacia senegal* trees. In this clay soil, spate irrigation systems utilising of Abu Habil seasonal streams with gates, bunds and canals are used to direct water flow to farmland cultivated with millet, sorghum, sesame, cotton, groundnuts, and vegetables [6]. Other examples were in the Alain reserved forest that was established by water catchment harvesting system such as drilling methods in Z shapes of water ponds pockets for planting trees, sails, and cutters, which led to increased tree growth and encouraged citizens to plant trees. In Sudan, ancient practices have been used in ancient forms such as agriculture activities for example, to keep moisture on soil, traditional pits were used. There are many reasons for the application of water harvesting, include climatic changes, occasional droughts, and floods, achieving strategic objectives in food and water security, development of natural pastures and forests, and through various means, including dams. The overall objective of this study is to determine the response of five fodder tree species to establishment using water harvesting techniques and supplementary irrigation in *Wad Elbaga* research farm in Sheikan locality, North Kordofan State in two seasons 2016 – 2018. While the specific objectives were: 1. to evaluate seedlings' growth characteristics and survival rate at field stage; 2. to measure the effect of water harvesting techniques on the growth performance of selected species in the field.

2. Materials and Methods

In an agricultural research farm in *Wed elbaga* area, land preparation was conducted in a Completely Random Design (CRD) in 3 treatments x 4 replicates x 5 species in April 2016 by three atoms of each container for seeds *Acacia senegal* (*Hashab*), *Faidherbia albida* (*Haraz*), *Acacia mellifera* (*Kitir*), *Acacia seyal*, *Acacia tortillis* (*Seal*). Three seedlings were chosen and measured their performance growth parameters of five studied fodder trees species, including *Acacia senegal*, *Acacia tortillis*, *Acacia mellifera*, *Faidherbia albida*, *and Acacia seyal*. Then seedlings' shoot and root length (m) using a ruler. On other side shoot and root fresh and dry weight per gram were assessed by a sensitive balance. The dry weight was assessed after stored fresh seedlings in oven with 80 degrees in temperature for 24 hours and finally calculating of measurement average. The data were analysed by the use of software (SAS) in which analysis of variances and means separation were done for all experiments and compared by Duncan multiple range.

3. Results

3.1 Effects of treatment on survival rate of the selected five fodder species saplings growth

The result of the study illustrated that sapling survival rate were varied between treatments (Table 1). In this table it's founded that the high survival rate is 100% in *Acacia mellifera*, *Acacia senegal* and *Acacia tortillis* species in water harvesting and supplementary irrigation treatments, while it's shows low 77.8% in *Acacia seyal* and *Faidherbia albia* in the same treatments. From the other hand in control and supplementary irrigation applications the high survival rate was 66.7% in *Acacia mellifra,* followed by 55.6% and 11.2% in *Acacia senegal* and *Acacia tortillis,* respectively. While *Acacia seyal* and *Faidhrebia albida* seedlings were dead in the control without irrigation, in which survival is equal zero. Accordingly, total survival rate was founded high 55.6% in *Acacia mellifera* followed by 51.8% in *Acacia senegal* while low 25.9% in *Acacia seyal* and *Faidherbia albida,* respectively.

3.2 Effects of seasons on five fodder species saplings survival rate

The result of the study indicated that the survival rate was varied between fodder species in two seasons 2016 and 2017 (Table 2). It's found high survival rate was 100% in *Acacia mellifera* followed by 96.3% in *Acacia senegal*, 92.6% in *A. seyal* and 77.8% in *Faidherbia albida* in summer (2016). Also, it was found high 100% in *Acacia mellifera*, *A. senegal* and *Acacia tortillis,* followed by 96.3% in *Faidherbia albida* and 92.6% in *A. senegal* in autumn season 2016.

Furthermore, the survival rate percentage was founded equal 66.7% in *A. senegal,* followed by 63% in *A. mellifera* and low 44.5% in *A. tortilis*, 37% in *A. seyal* and 33.4% in *Faidherbia albida during* season summer 2017. While in autumn 2017 the survival rate is less than autumn equal 55.6% in *A. mellifera* followed by 51.9% in *A. senegal* and low 37% and 26% in *A. tortilis* and *A. seyal* and *Faidherbia albida,* respectively.

3.3 Effects of seasons on sapling growth characters in the field

The result of study showed that the season 2016 has significant effects (P = 0.05) on sapling diameter, height and number of branches in autumn seasons and on sapling diameter and number of branches on summer season 2016 while no significant effects on sapling height in the summer season 2016 (Table 3). It appears that *Acacia senegal* has high (0.394mm) and (0.405mm) means sapling diameters in summer and autumn 2016 than *Acacia seyal* sapling diameter (0.265mm) and (0.271mm) in summer and autumn, respectively.

For sapling height growth there were no significant effects on sapling height in the summer season 2016 between all species, it was found equal (42.89cm), (38.33cm), (26.56cm), (22.97cm) and (19.47cm) in *A. mellifera*, *A. senegal, A. tortilis, A. seyal* and *Faidherbia albida,* respectively. While in autumn *A. senegal* has high (32.878cm) mean sapling height than *Acacia seyal* (18.148cm).

Furthermore, *A. senegal* has high (1.296) mean sapling number of branches than *A. mellifera* (0.444), *A. seyal* (0.482), *Faidherbia albida* (0.185) and *A. tortilis* (0.148) in summer. While in autumn *A. senegal* also has high (5.148) mean sapling number of branches than *A. mellifera* (2.926), *A. seyal* (1.370), *A. tortilis* (2.037) and *Faidherbia albida* (1.037).

In season 2017 the results of the study showed that this season had significant effects (P = 0.05) on sapling diameter, height and number of branches in summer and autumn between all species studies (Table 4).

It appears that *A. senegal* has a higher (0.24mm) mean sapling diameter than *A. seyal* sapling diameter (0.09mm) in summer while in autumn, *A. seyal* has high (0.466mm) mean sapling diameter than *Faidherbia albida* (0.6296mm). Also *A. mellifera* has a higher (12.14mm) sapling diameter than *A. Senegal* (11.4mm) and *Faidherbia albida* (2.944mm) sapling diameter in summer 2017. While in autumn, *A. senegal* has a high (17.84cm) mean sapling height, the *A. mellifera* (15.5 cm), *A. tortilis* (13.33cm), *A. seyal* (10.14cm) and *Faidherbia albida* (5.00cm).

Furthermore, *A. senegal* has a higher (2.074) mean sapling number of branches than *A. mellifera* (1.852), *A. tortilis* (1.037), *Faidherbia albida* (0.6296) and *A. seyal* (0.593) in the summer season 2017. While in autumn season 2017, A. mellifera also has a higher (5.148) mean sapling number of branches than *A. senegal* (4.741), *A. tortilis* (2.889), *A. seyal* (1.926) and *Faidherbia albida* (1.222).

Table (1): Effects of treatment on survival rate of selected five fodder species saplings growth

Species Name	Treatment									Total Survival Rate (%)
	Water harvesting + supplementary irrigation			Supplementary+ irrigation			Control without irrigation			
	Living sapling	Dead sapling	Survival rate (%)	Living sapling	Dead sapling	Survival rate (%)	Living sapling	Dead sapling	Survival rate (%)	
A. mellifera	9	0	100	6	3	66.7	0	9	0	55.6
A. senegal	9	0	100	5	4	55.6	0	9	0	51.8
A. seyal	7	2	77.8	0	9	0	0	9	0	25.9
A. tortillis	9	0	100	1	8	11.2	0	9	0	37.03
F. albida	7	2	77.8	0	9	0	0	9	0	25.9
Total	41	4	**91.2**	12	33	**26.7**	0	45	**0**	**39.3**

Table (2): Survival rate of five fodder species saplings in season 2016 and 2017

Species name	Season 2016						Season 2017					
	Summer			Autumn			Summer			Autumn		
	Living sapling	Dead sapling	Survival Rate	Living sapling	Dead sapling	Survival rate	Living sapling	Dead sapling	Survival Rate	Living sapling	Dead sapling	Survival Rate
A. mellifera	27	0	100	27	0	100	17	10	63	15	12	55.6
A. Senegal	26	1	96.	27	0	100	18	9	66.7	14	13	51.9
A. seyal	25	2	92.6	25	2	92.6	10	17	37	7	20	26
A. tortillis	25	2	92.6	27	0	100	12	15	44.5	10	17	37
F. albida	21	6	77.8	26	1	96.3	9	18	33.4	7	20	26
Total	124	11	**91.9**	132	3	**97.8**	66	69	**48.9%**	53	82	**39.3**

Table (3): Effects of seasons on sapling growth characters of five fodder species (2016)

Species name	Summer			Autumn		
	Diameter (mm)	Height (cm)	No. of Branches	Diameter (mm)	Height (cm)	No. of Branches
A. mellifera	0.36^{A}	42.89^{A}	0.444^{B}	0.397^{A}	31.256^{A}	2.926^{BC}
A. senegal	0.394^{A}	38.33^{A}	1.296^{AB}	0.405^{A}	32.878^{B}	5.148^{AB}
A. seyal	0.265^{B}	22.97^{A}	0.482^{B}	0.271^{B}	18.148^{A}	1.370^{A}
A. tortillis	0.302^{A}	26.56^{A}	0.148^{C}	0.337^{A}	26.541^{A}	2.037^{A}
F. albida	0.306^{A}	19.47^{A}	0.185^{B}	0.228^{A}	18.652^{A}	1.037^{A}

*Means followed with the same letters are not significantly different at p≤ 0.05. *: significant different between means.*

Table (4): Effects of seasons on sapling growth characters of five fodder species (2017)

Species name	Summer			Autumn		
	Diameter (mm)	Height (cm)	No. of Branches	Diameter (mm)	Height (cm)	No. of Branches
A. mellifera	0.218^{AB}	12.14^{C}	1.852^{BC}	0.457^{A}	15.15^{C}	5.148^{A}
A. senegal	0.24^{AB}	11.4^{AB}	2.074^{A}	0.400^{A}	17.84^{B}	4.741^{B}
A. seyal	0.090^{B}	4.426^{B}	0.593^{B}	0.466^{A}	10.14^{B}	1.926^{A}
A. tortillis	0.114^{B}	8.681^{B}	1.037^{B}	0.283^{A}	13.33^{B}	2.889^{A}
F. albida	0.047^{C}	2.944^{B}	0.6296^{B}	0.132^{B}	5.000^{B}	1.222^{A}

*Means followed with the same letters are not significantly different at p≤ 0.05. *: significant different between means.*

3.5 Effects of treatments on sapling growth characters in the field

The result of the study showed that water catchment and supplementary irrigation treatments had effects (P = 0.05) on saplings' diameter, height, and number of branches on the fields between all studied fodder species (Table 5).

A. seyal has high (4.00mm) mean sapling diameter growth than *A. mellifera* (0.364mm), *A. senegal* (0.359mm), *Faidherbia albida* (0.337mm) and *A. tortilis* (0.090mm) in water catchment with supplementary irrigation treatment, while *A. tortilis* has high (0.466mm) mean sapling diameter performance than *A. mellifera* (0.397mm), *A. senegal* (0.394mm), *A. seyal* (0.3595mm) and *Faidherbia albida* (0.114mm) sapling diameter growth on control with supplementary irrigation. But in control without irrigation *A. senegal* has high (0.405mm) mean sapling diameter than *Faidherbia albida* (0.283mm), *A. tortilis* (0.273mm), *A. seyal* (0.265mm) and *A. mellifera* (0.218mm).

Furthermore, *A. mellifera* has high (42.89cm) mean sapling height than *Faidherbia albida* (26.54cm), *A. senegal* (25.36cm), *A. seyal* (17.84cm) and *A. tortilis* (4.426cm) in water catchment with supplementary irrigation treatment. While in control with supplementary irrigation *A. senegal* has high (38.33cm) mean sapling height than *A. mellifera* (31.26cm), *A. seyal* (25.114cm), *A. tortilis* (10.14cm) and *Faidherbia albida* (8.68cm).

In control without irrigation *A. senegal* has high (32.88cm) mean sapling height than *A. seyal* (22.97cm), *A. tortilis* (13.92cm), *Faidherbia albida* (13.33cm) and *A. mellifera* (12.14cm) sapling height.

Moreover, *A. seyal* has high (4.741) mean sapling number of branches than *A. Senegal* (2.593), *Faidherbia albida* (2.037), *A. tortilis* (0.593) and *A. mellifera* (0.444) in water catchment with supplementary irrigation treatments. While in control with supplementary irrigation *A. seyal* also has high (3.315) mean sapling number of branches than *A. mellifera* (2.926), *A. tortilis* (1.926), *Faidherbia albida* (1.037) and *A. senegal* (1) sapling number of branches. But, in control without irrigation *A. senegal* has high (5) mean sapling number of branches than *Faidherbia albida* (2.889), *A. mellifera* (1.852), *A. tortilis* (1.093) and *A. seyal* (0.482).

4. Discussion

The study was founded that different between five fodder species mother trees growth performance and measurement characteristics in field may be due to variation in equipment used where the machines are affected by many factors tools precision, age of trees and site condition this maybe agreed with [10] who stated that "forest workers does not permit the use of sensitive equipment to the accuracy expected that is normally within the limits permitted by this equipment".

Table (5): Effect of treatments on growth characteristic of selected saplings fodder species in seasons 2016/2017

Species Name	Treatments											
	Water catchment + Supplementary irrigation			Control + supplementary			Control without irrigation			Means		
	Diameter (mm)	Height (cm)	No. of Branches	Diameter (mm)	Height (cm)	No. of Branches	Diameter (mm)	Height (cm)	No. of Branches	Diameter (mm)	Height (cm)	No. of Branches
A. mellifera	0.364^{A}	42.89^{A}	0.444^{B}	0.397^{A}	31.26^{B}	2.926^{BC}	0.218^{AB}	12.14^{C}	1.852^{BC}	0.457^{A}	15.19^{C}	5.148
A. senegal	0.359*	25.360*	2.593*	0.394^{A}	38.33^{A}	1.0^{B}	0.405^{A}	32.88^{A}	5.0^{A}	0.2396^{B}	11.41^{B}	2.074^{B}
A. seyal	0.400^{A}	17.84^{B}	4.741^{A}	0.3595*	25.114*	3.315*	0.265^{B}	22.97^{A}	0.482^{B}	0.271^{B}	18.15^{A}	1.37
A. tortillis	0.090^{B}	4.426^{B}	0.593^{B}	0.466^{A}	10.14^{B}	1.926^{A}	0.273*	13.921*	1.093*	0.302^{A}	26.56^{A}	0.148^{C}
F. albida	0.337^{A}	26.54^{A}	2.037^{A}	0.114^{B}	8.681^{B}	1.037^{B}	0.283^{A}	13.33^{B}	2.889^{A}	0.259*	18.78*	1.528*

*Means followed with the same letters are not significantly different at p≤ 0.05. *: significant different between means.*

The variations between five fodder species' seeds physiology and morphology characters assessment in the laboratory may be due to sort and mixing of collected seeds with other species' seeds and the presence of impurities, and the exposure of seeds to infection by insects. The study support that lacks of collection of seeds at the time of maturity offers them to fall and open the centuries, which affects the quantities of seeds and the lack of appropriate environmental conditions, shortening the abundance of seeds. Fodder species seedling growth variability in the nursery stage may be due to differences in seed characteristics, especially viability, purity and moisture contents, which affect seedlings' growth, germination speed and rate that is reflected on the increase of the total shoots and roots in good soil moisture. This is agreed with [16] who stated that "Relative humidity in the atmosphere and soil moisture play an important role in the growth, spread and density of trees".

The deviation between five fodder species effects of treatment on the survival rate and sapling grow performance in filed may be due to increasing the amount of water availability around and under the sapling, which increased the moisture content in the soil as a result of the use of water harvesting and supplementary irrigation especially for *Acacia seyal* saplings. And the death of saplings in control without irrigation may be due to low humidity and this is agreed with [10] who reported the death of seedlings in the case of a decrease in the minimum humidity.

Fodder species saplings survival rates in the study area were varied in different season in filed and this may be due to increasing moisture content on soil during summer which had a positive effect on sapling survival rate. Saplings are exposed to eaten by rabbits especially in the summer season because of the lack of weeds around, which reflected negatively on the number of saplings and slow growth of saplings and this is agreed with [9] who reported that most of tropical trees were difficult to grow and were need more care in its early years and this slow growth continued until the roots reaches ground water. Also, water harvesting and conservation structures are very important contributors to tree survival [11]. The discrimination between five fodder species which were analysed the effect of seasons on saplings growth characters and performance in filed may be due to increase the moisture content during the autumn, which increased sapling height and diameter and number of branches, whereas increasing in age will increase sapling height which was considered a reflection of the suitability of environmental conditions. This was agreed with [10] who illustrated that environmental conditions affect tree growth characters. The significant different between five fodder species on saplings growth characteristics as a result of effect of treatment in filed may be due to the use water harvesting and supplementary irrigation techniques which were increasing moisture content availability saplings. From the other hand, a decrease in water availability in control without irrigation treatment may be the main cause of sapling death.

This agrees previous study on the use of water catchment with *U* and *L* shape on *Acacia mellifera*, *Acacia tortilis* and *Acacia seyal* seedling establishment in a control treatment which shows seedling death. It was showed that during both seasons, micro catchment techniques had significantly higher means of soil moisture content as compared to the control [12]. And he also mentioned that on the other hand, among the micro catchment techniques the V-shaped micro catchment technique reported a significantly higher mean of soil moisture content for all months in both seasons as compared to the other techniques, followed by the semicircular, pits and deep ditch micro catchments, respectively.

The significant different between five fodder species as effect of seasons on growth characters sapling performance in filed may be due to use during the summer maybe due to use of supplementary irrigation that increasing moisture contents in soil which had a positive effect on growth characters in sapling stem diameter, height and number of branches this is in the line with [10] who indicated that gratify reclamation desertification injury and water harvesting importance in natural resource maintenances and environmental rebalance.

5. Conclusions

The tests of seed purity, viability, number of seeds/kg and germination percentage were reported and differed between the studied species. Considering biomass production of seedling shoots and roots at the nursery stage within and between the studied fodder species was recognized. The soil analysis before experiments indicated that the site is very rich in soil mineral content and pH, and caution exchange capacity on depth studied. Water catchment with supplementary irrigation treatments has positive effects on species survival rate due to the addition of water and an increase of water holding capacity and application of micro-catchment techniques reducing of rainfall water runoff and increase availability of water specially for root systems for all species and improved site moisture in general. The study revealed that there were positive effects of water catchment and supplementary irrigation treatments on fodder trees sapling growth performance in the field.

6. Acknowledgement

The authors are very grateful to Forest Trees Seed Centre, Agricultural Research Corporation (ARC), North Kordofan State, Sudan for their support by providing funds and feasibilities for the study. Also, thanks go to FNC in North Kordofan State, Sudan and University of Kordofan. The assistance of colleges in verifying the information provided by the various supports and advice from friends, family and colleagues are also greatly appreciated.

References

1. Lange, M. De. (2006). *A literature study to support the implementation of micro-AWM technologies in the SADC region*.
2. Mtisi, S., & Nicol, A. (2013). *Good Practices in Water Development for Drylands*.
3. Bernard, A. and Springgay, E. (2016). Understanding the Forest Water Nexus: monitoring framework. In *"Understanding the Forest-Water Nexus: monitoring framework" expert workshop 27-30 September 2016.* (p. 32). Rome: FAO Forest and Water Programme.
4. Prinz, D., (1996). Water Harvesting: Past and Future. In: Pereira, L. S. (ed.), Sustainability of Irrigated Agriculture. Proceedings, NATO Advanced Research Workshop, Vimeiro, 21- 26.03.1994, Balkema, Rotterdam, 135-144.
5. Oweis, T., & Hachum, A. (2012). *Supplemental Irrigation, a highly efficient water-use practice* (Second). Aleppo, Syria: (ICARDA), International Center for Agricultural Research.
6. Dawelbeit, M. I. (2008). *Best Practicies for Water Harvesting and Irrigation*. Khartoum, Sudan: Efficient Water Use for Agricultural Production (EWUAP) Project, Nile Basin Initiative.
7. Dawson, I. K., Carsan, S., Franzel, S., Kindt, R., Graudal, L., Orwa, C., & Jamnadass, R. (2014). Agroforestry, livestock, fodder production and climate change adaptation and mitigation in East Africa: issues and options. *ICRAF Working Paper*, *178*, 31. https://doi.org/http://dx.doi.org/10.5716/WP14050.PDF
8. Zaroug, M. G. (2006). Country Pasture/Forage Resource Profiles by. *Food and Agricultural Organization (FAO)*, 20.
9. Vogt, K. (1995). A field guide to the identification, propagation and uses of common trees and shrubs of dry-land Sudan, SOS Sahel International (UK).
10. Nasroon, Tageldin Hussein (2000). Fundamental of Forests and its applications in drylands, Dar Aalm Alkitab, Reyad, Saudi Arabia.
11. Mwamburi, A., & Musyoki, J. (2010). *Improving Tree Survival in the Drylands of Kenya* (Information Bulletin No. 2). Nairobi, Kenya.
12. Aydrous, A. E., Moneim, A., Mohamed, E., Abdelbagi, A. A., Abdel, S., Salih, R., … Elsheik, M. (2015). Effect of Some Micro-Catchment Water Harvesting Techniques on Soil Moisture Content. *International Conference on Chemical, Civil and Environmental Engineering (CCEE)*.