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Influence of Different Water Frequency on the Growth and Yield of *Cymbopogon schoenanthus* (Camel Grass)

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Authors' contributions

This work was carried out in collaboration between all authors. Authors AMR and BLA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AMR and H.M. Maishanu managed the analyses of the study. Author H.M. Maikudi managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Cymbopogon schoenanthus is a biennial or perennial grass that grows in a dried stony environment, capable of withstanding harsh environmental condition. In this research, the influence of different water frequency on the yield of *Cymbopogon schoenanthus* was assessed. Plant sample was watered after three days, two days and one-day continuing for an interval of 12 months, But the controlled sample was watered daily. The growth of the grass was evaluated each week, up to the period when the plants were expected to reach vegetative and reproductive phase. The growth parameters estimated are plant height (cm), number of leaves per plant, number of seeds, flowers and stem or shoots bearing flowers. The result shows that samples were irrigated daily and yielded more followed by samples irrigated after one day or two days intervals. The yield and productivity of the grass samples examined was higher under conducive environmental

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condition. The seeds and inflorescent were obtained after four methods of cultivation in the samples which were watered daily. The seeds and flowers were dispersed by wind as the plant produced new seeds. This resulted in decrease in the number of seeds in some of the treatment, leading to less number of seeds in some of the treatments. From the research it shows that the water frequency has the effect on the growth of plant species.

Keywords: Cymbopogon schoenanthus; camel grass month after planting (MAP); irrigation frequency.

1. INTRODUCTION

Grasses are the most abundant species in plant kingdom having so many socio-economic potentials such as food, medicinal, insecticidal [1], shelter, land covering etc., Majority of the species were neglected or given less attention especially those that were indigenous to Africa. However, little attention and research were explored on the grass species which are of great benefit to human, environment, animals and others species. Besides, this problem mostly arises due to lack of sufficient water in most of the arid areas and high demand for food by the most individual which leads to the neglect the other economically important plant species. The production of such plants with little requirement of water and other basic needs in the production would help in exploring the economic importance because most of the grasses serve as a major food source, medicines etc.

Looking at the environmental condition of Sahel and Sudan savannah in the country, the lands are over exposed to so many environmental hazards. The utilization of these lands with less cost-effective, lesser water requirements, fertilizer and man power will help in revitalizing the abundant marginalized land, especially within Sokoto state (Nigeria), that is blessed with abundant land. However, the grass species that grows locally within this region are most tolerant to the harsh environmental condition.

Irrigation basically is described as the economic and sustainable application of water for optimum production of crops. An efficient irrigation method is that which best suits the local conditions such as soil characteristic of crop diversity, topographic condition, soil moisture flow and aquifer recharge [2]. Irrigation can be broadly classified into; surface irrigation, overhead irrigation and sub-surface irrigation methods. Each of these methods can be manipulate according to the desired result and level of water application depending on the type of crops and method of planting. Irrigation having few other uses in crop production, which include protecting plant against frost [2], suppressing weed growing in grain fields and helping in preventing soil consolidation [3,2].

Camel grass being a perennial grass with great drought tolerance like other higher vascular plants growing abundantly in northwestern part of Nigeria can serve as land cover and shelter to Biomes within the region as well as help in the formation of soil, production of viable Agricultural land as a result of the dropping of the death part or leaves (litter) of the plant within the area will help in composting the soil especially during raining season. In this research different irrigation frequency was subjected to the grass in order to assess its yield and tolerance to the different watering regimes. The aim of this research is to assess the influence of different watering regime on the growth of *Cymbopogon schoenanathus* (camel grass). The specific objectives are determined: Overall effect of irrigation frequency on the growth of the grass species. Effect of a one-day interval, two days and three days interval of watery regimes on *Cymbopogon schoenanthus*; and the Effect of different irrigation frequency on the seeds and flowers of camel grass.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in Biological Garden, Departments of Biological Sciences, Usmanu Danfodiyo University, Sokoto.

2.2 Collection of Samples

The sample of the grass was obtained from the main campus of Usmanu Danfodiyo University, Sokoto. Fifty Grams (50 g) of camel grass seeds were obtained by random selection of plants using hand picking method; the species were authenticated by comparison with a preserved specimen in the University Herbarium, Sokoto.

2.3 Viability Test and Transplanting

Seeds of Camel grass were planted in a nursery and watered daily without any fertilizer application. After 30 days of seedling growth, uniform germinated seedlings were transferred into plastic pots with an Area of 12.57 cm^2 and a depth of 7.5 cm filled with garden soil. Three seedlings were transplanted to each pot. It was then watered for a period of one week to acclimatize before imposing the treatments.

2.4 Induction of Irrigation Frequency

After two weeks of transplanting, irrigation frequency was imposed by reducing the amount of irrigation water per pot and irrigation frequency per week. Three watering regimes were constituted and the plants therefore formed into three groups. The first group was watered after three (3) days, the second group was watered with one litre of water after four (4) days and the third group was watered with one litre after one week. Each group was replicated three (3) times with each replicate consisting of the plant samples. This gives a total of three experimental set-ups by three replications by three plants.

2.5 Growth Evaluation

The growth of the grass was evaluated each week, for a period when the plants are expected to reach vegetative growth. The growth parameters evaluated are plant height (cm), number of leaves per plant, number of seeds, flowers and panicles.

2.6 Experimental Design and Data Analysis

Complete Randomized Design (CRD) was used for the experimental design. The data obtained were subjected to Analysis of Variance (ANOVA) and means that are significant were separated using Dunkan at 5% level of significance.

3. RESULTS

Fig. 1 shows effect of different irrigation frequency on the height of camel grass. The height of plants is significantly high in the samples irrigated daily followed by samples watered after two days and one day intervals. Samples watered after three days intervals show least height at all MAP except at third month after planting. The height increases with increase in day or age of the plants. The maximum height is achieved at sixth month after planting in samples watered daily (150.00 cm) followed by samples watered after two days (101.00 cm) and one day interval (91.67 cm). Samples watered after three days withered after five month of planting.

Fig. 2 shows the effect of different irrigation frequency on the leaves of camel grass. Significant difference occurs at first month after planting between the treatment and sample watered daily but no difference between stressed samples at all intervals from second month after planting to fifth month after planting. The difference was significantly high at sixth, seventh and tenth month after planting. However, eighth, ninth and eleventh MAP shows no significant differences between the one day and two days. Slight decrease was observed at fifth and eleventh MAP in samples watered after one day interval. Maximum number of leaves was obtained at sixth week after planting (553) under samples watered daily followed by samples watered after one day (369) and two days intervals (325). The number of leaves under three days intervals tend to degenerate at sixth Month after planting. The number of leaves increases with increase in number of days or age of the plants.

Fig. 3 shows the effect of different irrigation frequency on the tillers of camel grass. The result obtained shows higher number of tillers under samples watered daily while the stressed samples shows no significant difference at all days interval except between control sample (watered daily) and all the Treated samples. The number of tillers is significantly higher in the samples watered daily and all the treatment at first MAP to fifth MAP. Same thing happened from eighth MAP to twelfth MAP except eleventh MAP, which shows significant difference between the treatments (stressed samples). Highest number of tillers was observed at sixth MAP in daily samples (155), followed by samples watered after one day interval (131) and two days intervals (114) at eleventh MAP. The samples under three days intervals withered at fifth MAP.

The highest number of seeds (Fig. 4) was obtained in samples irrigated after one day interval at fourth and sixth MAP and differences between seed production of the remaining treatment is significantly high at 5% level of significance. While samples irrigated after one day and three days intervals produced seeds at seventh MAP. At fourth to seventh MAP the differences between all the samples was high (P<0.05). Samples irrigated after two days intervals produced the maximum number of seeds at tenth MAP.

The overall flower of camel grass samples (under treatment and control samples) four months (sixteen weeks) after planting is shown in Fig. 5. The flower emerged at sixteen weeks after planting and there was significant difference between the control and stressed samples of camel grass. The differences were high at twenty second week to thirty weeks after planting. Maximum number of flower was obtained at twenty seventh weeks after planting in the control samples (48.67) and in the camel samples (stressed samples) that's fourty four weeks after planting (39.50).

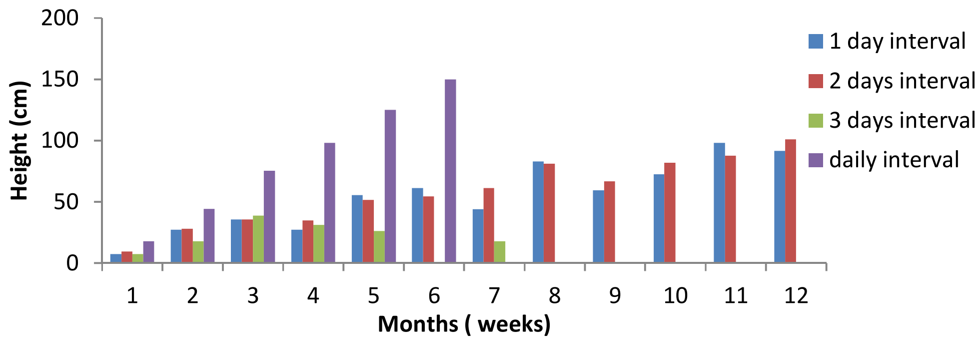

Fig. 1. Effect of different irrigation frequency on the height of camel grass

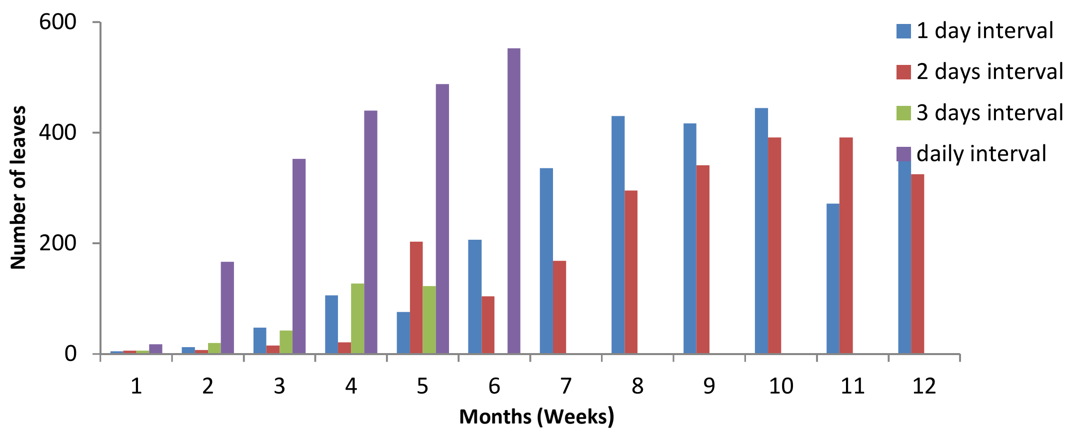

Fig. 2. Effect of different irrigation frequency on the leaves of camel grass

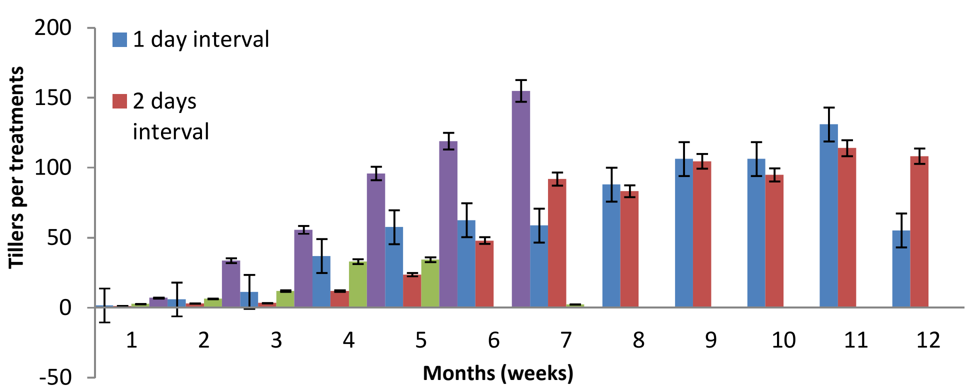

Fig. 3. Effect of different irrigation frequency on the tillers of camel grass

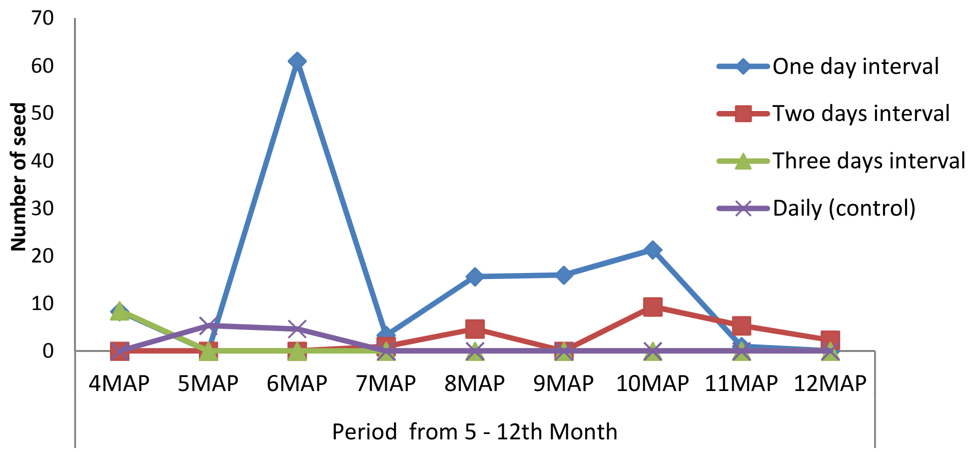

Fig. 4. Effect of irrigation frequency on number of seeds

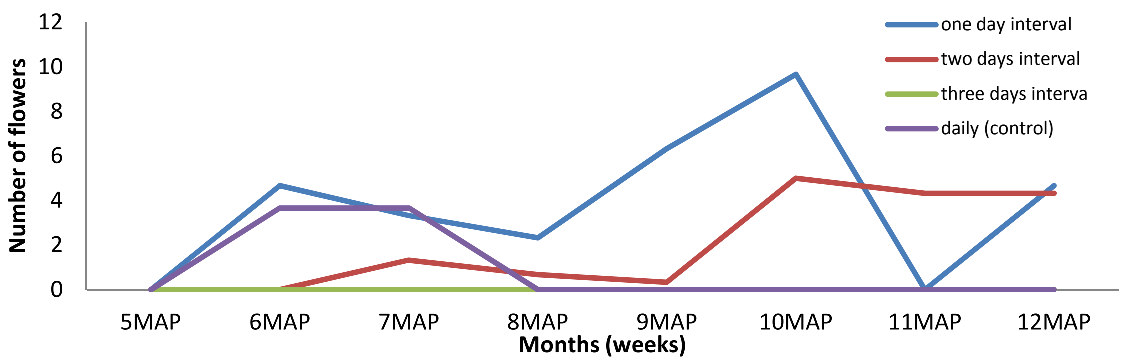

Fig. 5. Effect of irrigation frequency on number of flowers

Table 1 shows the effect of Irrigation frequency on number of panicles. The seeds started to emerged at fifth month after planting in samples watered daily and three days intervals. The mean number of seeds is significantly different. At sixth month after planting the number of seeds is slightly different in samples stressed after one day and daily. However, all the samples show significant difference in all the month except eight month after planting. The number of seed is high at tenth month after planting (9.67) and eleventh month after planting (9.67) the number of seed is not much for samples watered daily.

4. DISCUSSION

The growth process of the grass species, at the early stage of germination was slow this was attributed to seed germination processes that occur in the samples. The seedlings emerged in the first week of protrude of the tips from the seeds after water is being absorbed. In the second week, the emergence of leaves from the stalk was noted. Looking at the stage of grass growth, three main stages were observed. The first stage shows a vegetative stage, second stage transition stage and the third stage was the reproductive stage [4].

In the vegetative stage, favourable environmental condition plays an important part in the growth of the plant species. But in this research, different watering regime (water stress) was taken into consideration for the growth tolerance of the plant; samples irrigated daily shows fastest vegetative growth in the first three month of planting. Though, it's a little slow after germination, later a rapid increase and fast growth was noted. This is in line with the rules of growth as described by [4], who stated that during lag phase or second phase of growth, the growth rate is faster. Samples watered after two days and one day interval shows slight significant differences at all stages.

Table 1. Effect of Irrigation frequency on number of panicles

Irrigation frequency	Period from 5- 12th month							
	5MAP	**6MAP**	**7MAP**	**8MAP**	**9MAP**	**10MAP**	**11MAP**	**12MAP**
One day interval	0.00^b	4.67^a	3.33^a	2.33*	6.33^a	9.67^a	9.67^a	4.67^a
Two days interval	0.00^b	0.00^c	1.33^{ab}	0.67*	0.33^b	5.00^b	4.33^b	4.33^b
Three days interval	2.50^a	0.00^c	0.00^b	0.00*	0.00^b	0.00^c	0.00^c	0.00^c
Daily (control)	1.00^{ab}	3.67^b	3.67*	0.00*	0.00^b	0.00^c	0.00^c	0.00^c

The increase in height was slow in the first MAP which is the lag phase of plant growth; later in the following months (second MAP) a simultaneous rapid increase in height was noted. From third to fourth month a rapid increase in height was observed. The rapid increase was noted in samples irrigated daily while sample under water stress where lagged behind. The first two to three months in the life cycle of the plant is the vegetative phase of growth in which species started to grow and bears the vegetative feature such as leaves, stem/stalk. However, at this stage or phase the plant samples watered daily (control group) starts to mature. While the sample under water stress reached their vegetative maturity from eight to ninth MAP this happen as a result of environmental stressed especially water stress face by the plant, high light intensity and high temperature which affect the physiological activities such as growth in the plant.

Reproductive stage of the plant irrigated daily was from the ending of fourth MAP to sixth MAP where the life cycle was completed. Similarly, sample under water stress reached their reproductive stage from the ending of sixth Map to twelfth MAP. The reproduction was slow, which lasted a period of four to five month in some of the tested sample; when compared to the samples irrigated daily, life cycle was completed within two months after reaching maturity.

Moreover, it was observed that vegetative growth maturity and reproduction was higher in samples irrigated daily than the species under stressed. Similarly, the effect of each watering regime on the tested species (one day interval, two days interval and sample irrigated daily) shows no significant difference from the beginning of plant growth. But as the plant matured the difference become prominent between all treatments. A tremendous gap interval was noted between all treatment, daily samples and samples under three days interval. The decrease in height in some of the samples at fourth MAP was due to high intensity of light and increase in temperature within the periods of growth.

However, water stress has effect on the leaves productivity, as the water supply was adequate, the number of leaves produce tend to increase. The increase in the number of leaves determines the physiological activities of the species. Despite all other factors, water plays a greater role in activities such as food synthesis or production in the process of photosynthesis. The results obtained, during the first period of growth under all the watering regimes shows that, the growth rate is slow with certain fluctuation in the number of leaves, this happens as a results of stress that happens at certain interval of growth as indicated in Figs. 1, 2 and 3. During the period, the number of leaves decreases within fourth and sixth MAP. This could be due to high intensity of light and temperature which resulted in high photosynthetic activity and evapotranspiration within the plant samples. However, for the process to take place water is needed and the water level is lower than the basic requirements of the plant species.

While control samples are under a conducive environmental condition and the water requirement was sufficient enough for the plant to carry out its physiological activities. This resulted in growth and productivity with an increase in leaf number. Moreover, due to sufficient water requirement of the sample irrigated daily, the highest number of leaves was obtained within sixth MAP. While water stress effects the number and vegetative growth of the leaves under two days intervals, it extended longer than samples irrigated daily to a period of three month.

The vegetative growth of the species was determined by the total number of leaves. The leaves calculate the height of the plant. In some situations the leaves withered as a result of high environmental conditions such as temperature. The height of the plants is affected so also the number of tillers. The more the number of leaves produced the more the tillers are produced as the plant aged and matured. It become dense and tufted new shoots and leaves are produced at the base. Water stress affects the growth activities (number of leaves and tillers) of the species samples.

According to [5], water stress has adverse effect on main aspect of the physiology of plants, especially photosynthetic capacity. If the stress is prolonged the plant growth and productivity are severely diminished. However, the plants growth and productivity are adversely affected by water stress. It determines the development of plants, increase survivability and growth. Though plant developed various mechanisms to reduce their consumption of resources and adjust their growth to adverse environmental conditions [4,6,7].

Plant stress is impaired by severe drought stress due to a decrease in stomatal opening which limits carbon dioxides uptake and hence reduces photosynthetic activity. Plant growth was anchored by photosynthesis; however, excess light can cause severe damage to plants. Excess light induces photo-oxidation, which results in the increased production of highly reactive oxygen intermediates that negatively affect biological molecules, and if severe, a significant decrease in plant productivity [8]. Water stress is controlled by complex regulatory events such as Abscisic acids and activities of transcript factor that regulates the opening and closing of the stomata which enables the plants to adapt and survive.

Naresh [9] pointed out that long term water stress effects on metabolic reactions are associated with plant growth stage, water storage capacity of soil and physiological aspects of plant. Plants in water stress make changes in some of their physiological and biological features. Though, drought stress conditions causes low grain yield,; and in water stress conditions cultivars that have more chlorophyll content, proline content, canopy , low air and temperature are tolerant to drought stress.

According to [10], plant performance under water stress effect various physiological processes associated with growth, development and economic yield of a crop [11]. Water deficits disturb normal turgor pressure and the loss of cell turgidity may stop cell enlargement that causes reduced plant growth. Water stress increases root shoot ratio, thickness of cell wall and amount of cutinisation and lignification. It decreases leaf area index. Economic important crops such as maize, wheat, rice, barley belonging to poeacea family and other food crops are affected by changes in water potentials at important stages [12]. In the field water deficits do not act alone, but also with high temperature and high light stressed [13].

Lack of ample moisture for Agricultural productivity affect plant growth and development, life cycle and biomass accumulation. The main consequences in plant growth are reduction of rate of cell division, expansion, leaf size, stem elongation, root proliferation, disturbed stomata oscillations, plant water and nutrient relations with diminished crop productivity and water use efficiency [15].

In addition, limited water supply trigger a signal that causes an early switching of plants development from the vegetative to reproductive phase [14]. Different plants respond differently to drought, upon exposure to drought, flowering is delayed in maize, soybeans, wheat, barley. In some cases drought hastened flowering and physiological maturity. Water stress occurring during the vegetative period of plant growth, may substantially decreases economic yield. During flowering, water stress is critical it can decrease pollen sterility lead to hampered grain set [14].

Long term drought stress effects on plant metabolic reactions are associated with plant growth stage water storage capacity of soil and physiological aspects of plant. Naresh [9] states that plants in drought stress produce low grain and in drought stress conditions cultivars that have more chlorophyll contents, canopy low air and temperature are more tolerant to drought stress.

According to [10], plant performance under water stress or under condition of water stress effect various physiological processes associated with growth, development and economic yield of a crop [11]. Water deficits disturb normal turger pressure and the loss of cell turgidity may stop cell enlargement that causes reduced plant growth. Water stress increase root shoot ratio, thickness of cells walls and amount of cutinization and lignifications. It decreases leaf area index [10].

A plant with large mass of leaves loses water faster than the roots can supply and the water given to the plant is limited [15]. According to [15], plant responds to water stress by halting growth and reducing photosynthesis and other plant processes in order to reduce water use. As water loss progresses, leaves of some species may appear to change colour- usually to blue - green foliage begins to wilt, and if the plant is not irrigated, leaves will fall off and will eventually die.

Environmental factors have effect on water stress in plant [15], such as high intensity, high temperature, low relative humidity and high wind speed significantly increase plant water loss. A plant that has been drought stress previously and has recovered may become more drought resistant [16,17]. Also a plant that was well water prior to drought will usually survive drought better than a continuously drought stressed plant.

5. CONCLUSION

In summary, three different irrigation frequency (one, two and three days intervals with a control set which was watered daily) were imposed on camel grass. Samples irrigated daily yielded more followed than samples irrigated after one day and two days intervals. The yield and productivity of the grass samples tested was higher under conducive environmental condition. The seeds and inflorescent were obtained after four methods of cultivation in the samples watered daily. The seeds and flowers were dispersed by wind as the plant produced new seeds. This results in decrease in number of seeds in some of the treatment, resulting in less number of seeds in some of the treatments.

6. RECOMMENDATION

1. Growing of camel grass would provide cover to exposured abundant unutilized lands.
2. The production of indigenous plant resources should be encouraged and supported in order to provide shelter and conservation of living species and other soil properties.
3. The cultivation of the grass species would help in formation and retaining quality of soil texture and soil conservation.
4. Watering regime of two days intervals should be considered instead of one day and three day days interval to reduce water wastage.
5. The grass production will help reduce desert encouragement, over exposure of the land to excessive temperature and light intensity which will reduce the quality of the soil.
6. Encourage planting of camel grass plant in an open land because of its low financial input and maintenances which help reduce environmental hazards.
7. Further research should be conducted on root biomass of the grass species, gene expression of the stressed samples and role of the plant in soil in rocky environments.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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