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Effect of Water Stress on the Growth and Yield of Rhodes Grass (*Chloris gayana. L. Kunth.*)

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Abstract
Efficient irrigation is an important aspect to get good quality fodder. By keeping this fact in view a field experiment was conducted at Siddique Farm, Tando Adam, Sindh-Pakistan, to investigate the effect of water stress on Rhodes Grass (*Chloris gayana. L. Kunth.*). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Thus, the total number of plots was fifteen and the size of each plot was (16m x16m). The Rhodes grass (Fine-cut Variety) i.e. 10 kg/ acre was sown on (March 15, 2013) in the prepared land and Phosphorous fertilizer dose applied at sowing accordingly. The watering treatments comprised of five irrigation watering treatments (5, 10, 15, 20 and 25 days) (I_1, I_2, I_3, I_4 and I_5 respectively). Nitrogen was applied in split doses by broadcasting. The results revealed that I_2 showed high yielding results for all the agronomic parameters i.e. maximum plant height (125.38 cm), tillers / plant (4.86), leaves / tillers (10.13), leaf area (307.05 cm^2), green fodder yield (22.35 ton/ha/cut), and crude protein content (9.77) respectively. I_2 also produced highest (6.41 ton/ha/cut) dry fodder yield per hectare per cut. Too early or late watering reduced the yield and yield parameters of Rhodes grass. However, further investigations are necessary to establish the present findings in other regions of Pakistan as the seed variety (Fine-cut) was used in this study therefore; results may vary for other type of seed varieties.
Keywords: Rhodes Grass, Nitrogen Fertilizer, Fine-cut, Water Stress, Irrigation, Agriculture, Crude protein, Pakistan.

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INTRODUCTION

Rhodes grass (*Chloris gayana.* L. Kunth.) is an important tropical grass widespread in tropical and subtropical countries. It is useful forage for pasture and hay, drought-resistant and very productive, of high quality when young (Feyissa, 2000). It was mainly originated from African Countries i.e. (South Africa, Kenya, and Zimbabwe). Rhodes grass is a perennial or annual tropical grass. It is a leafy grass, 1-2 m in height, highly variable in habit. The culms are tufted or creeping, erect or decumbent, sometimes rooting from the nodes. The leaves are linear, with flat or folded glabrous blades, 12-50 cm long x 10-20 mm wide, tapering at the apex (Valenzuela *et al.,* 2002). The seed head has an open hand shape and encompasses 2-10 one-sided or double-sided racemes, 4-15 cm long. The inflorescences are light greenish brown (rarely yellow) in colour, and turn darker brown as they mature. The spikelets (over 32) are densely imbricated and have two awns. The fruit is a caryopsis, longitudinally grooved (Cook *et al.,* 2005).

In Pakistan, fodder production is very important because the fodder is a basic source of energy utilized for feeding the livestock. It can successfully provide the fodder for animal during the lean period. According to the past studies it can be noted that Rhodes grass cultivation started in 2008 on large scale and cultivated on more than 1 lac acres of Sindh, Punjab and some areas of Balochistan, which is utilized for fodder production. Rhodes grass in hay form is very much popular around the globe especially in gulf regions i.e. UAE, Qatar, Oman and KSA. Rhodes grass has high protein value (9 – 12%) and the average water consumption for its production is about 600 mm to 1200 mm. Rhodes grass sowing can be done from March to April and August to September in arid regions of the country where summer comes early. One time sowing of Rhodes grass will give the

production to the growers for about 3-4 years (Arshad, 2012).

Production of Rhodes grass was remarkable when proper and efficient fertigation was applied. However, the excessive use of irrigation water can reduce the quality and production parameters. Over irrigation should to be controlled during the initial growth stage or the safe keeping of grass (Quattrocchi, 2006). Considering this fact in view, the present study was conducted at Siddique Farms, Tando Adam. The primary focus of this research was to study the effect of water stress on the growth and yield of Rhodes Grass, and to find out the most suitable watering interval for the climatic conditions of Tando Adam, Sindh, Pakistan.

MATERIALS AND METHODS

The present study was conducted in Siddique Farms Tando Adam, Sindh – Pakistan in March 2013. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Thus, the total numbers of plots were fifteen and the size of each plot was (16m x16m). With the objective to ensure uniform distribution of irrigation water, initially weeds and extra grass were cleared by using two split crosswise cultivator operations supplemented with disk plow respectively. The land was then rough leveled by tractor with front and rear blade. In order to break the big mud stones (particles) of soil in to small fine particles the wooden deck and rotavator was used to ensure effective germination. After leveling pre- irrigation of 1 acre-inch of irrigation water was supplied in order to observe re-growth of grass and weeds. Then after 4-5 days the grown weeds and grass were cleared by using cultivator and tooth harrow operation accordingly. Finally, with the help of border maker the prepared land was divided into small sub-plots to carry out the pilot study.

The Rhodes grass (Fine-cut Variety) i.e. 10 kg/ acre was sown on (March 15, 2013) in the prepared land and 50 kg / acre phosphorous fertilizer (DAP) dose applied at sowing accordingly. The watering treatments comprised of five irrigation watering treatments (5, 10, 15, 20 and 25 days) (I_1, I_2, I_3, I_4 and I_5 respectively). 100 kg / acre nitrogen was applied in split doses by broadcasting in different interventions of growth period. All the plots were having equal amount of fertilizer doses throughout research work. Altogether two cuts at 50% flowering stage were obtained during the study period. The first and second cut was harvest after 45 days and 40 days respectively. 20 plants were selected at random in each plot at 50% flowering stage for cutting the Rhodes grass crop for fodder purpose. The economic and qualitative parameters studied during the pilot study was plant height, tillers / plant, leaves / tillers, leaf area, green fodder yield, dry matter yields, crude protein, ether extract, crude fibre, nitrogen free extract, and ash contents respectively. For quality tests the dried samples of all the plots were chopped separately into small pieces and send to Qualitest Laboratory, North Nazimabad, Karachi - Pakistan; where proximate composition was conducted. Finally, data analysis and statistical analysis were done through ANOVA procedure.

RESULTS AND DISCUSSION

The subject research was carried out to check the performance of Rhodes grass yield and growth rate for five different watering treatments. The outcome of the study revealed that Rhodes grass plant height, tillers / plant, leaves / tillers, leaf area, green fodder yield and dry matter yields, crude protein, ether extract, crude fibre, nitrogen free extract, and ash contents differed very significantly at ($P \leq 0.05$) as shown in Table 1 and Table 2 respectively. The critical gathered observations and data for the above discussed parameters during the research study are appended below:

Economic Characters Studied for Rhodes Grass

Plant Height

The response of the watering treatment to the plant height was found highly significant (Table 1). The lowest plant height was observed in I_5 (108.58 cm) followed by the I_1 (110.03 cm). However, the highest plant height was attained by I_2 (125.38 cm) followed by the I_3 (116.88 cm) respectively. Similar results were obtained for plant height for Rhodes grass by (Arshad, 2015), who also observed the variation in Rhodes grass for the plant height.

Tillers / Plant

Different watering treatments response to the tillers/plant was observed highly significant (Table 1). The lowest tillers/plant was observed in I_1 (4.02) followed by the I_5 (4.09). However, the highest tillers/plant was attained by I_2 (4.86) followed by the I_3 (4.63) respectively. These results were according to the observation of (Saad, 2010), who also observed the variation in Rhodes grass cultivars for the tillers/ plant.

Leaves / Tiller

The analysis of variance (Table 1) indicated that all watering treatments were highly significant ($P < 0.05$) for the leaves / tiller. Once again the highest leaves /tiller was attained by I_2 (10.13) followed by the I_3 (9.17) respectively. However, the lowest leaves / tillers was observed in I_5 (8.65) followed by the I_1 (8.79) respectively. The statistical analysis showed that these watering treatments were statistically same for this trait. These results were totally according to the observations of the (Ali *et al.,* 2001).

Leaf Area

Different watering treatments response to the leaf area was observed highly significant ($P < 0.05$) as described in (Table 1). It has been observed that I_2 showed highest leaf area (307.05 cm^2) followed by I_3 (283.59 cm^2) and lowest leaf area was observed for I_5 (266.35 cm^2) followed by I_1 (273.24 cm^2) respectively. Similar results were obtained for leaf area for Rhodes grass by (Yossif *et al.,* 2013), who also observed the variation in Rhodes grass for the leaf area.

Green Fodder Yield

All watering treatments showed the highly significant ($P < 0.05$) differences for the green fodder yield per hectare per cut (Table 1). The maximum average yield for green fodder per hectare was observed for the I_2 (22.35 ton/ha/cut) followed by I_3 (19.86 ton/ha/cut), while the lowest yield per hectare was observed for the I_5 (16.79 ton/ha/cut) and I_1 (18.02 ton/ha/cut) respectively. Similar results were obtained for green fodder yield for Rhodes grass (Mirza *et al.,* 2002).

Dry Fodder Yield

Different watering treatments response to the dry fodder yield was observed highly significant (Table 1). The lowest average dry fodder yield per hectare observed in I_5 (4.16 ton/ha/cut) followed by the I_1 (4.75 ton/ha/cut). However, the highest dry fodder yield per hectare was attained by I_2 (6.41 ton/ha/cut) followed by the I_3 (5.34 ton/ha/cut) respectively. These results were according to the observation of (Brima, 2011), who also observed the variation in Rhodes grass for the dry fodder yield.

Table 1. Effect of different watering treatments on quantitative parameters of Rhodes Grass.

Watering Treatment	Plant Height (cm)	Tillers / Plant	Leaves / Tiller	Leaf Area (cm^2)	Avg. Green Fodder Yield (t/ha/cut)	Avg. Dry Fodder Yield (t/ha/cut)
I_1	110.03bcd	4.02cd	8.79bc	273.24b	18.02cd	4.75bc
I_2	125.38a	4.86a	10.13a	307.05a	22.35a	6.41a
I_3	116.88b	4.63ab	9.17b	283.59b	19.86b	5.34b
I_4	113.94bc	4.17bc	8.89bc	278.41b	19.13bc	4.86bc
I_5	108.58cd	4.09cd	8.65cd	266.35b	16.79d	4.16d

Means followed by different letter shows significant result at 5% level of significance.

Qualitative Parameters Studied for Rhodes Grass

In order to determine the quality and nutritive value of different qualitative parameters of Rhodes grass the dried samples of all the plots were chopped separately into small pieces and send to Qualitest Laboratory, North Nazimabad, Karachi, Pakistan. The qualitative parameters studied were crude protein, ether extract, crude fibre, nitrogen free extract, and ash contents respectively. The data revealed that the highest crude protein contents of (9.77%) were recorded for the I_2 followed by I_3 (9.69%), while the lowest crude protein content was found in I_5 (6.75%) respectively. Similar results were obtained for crude protein content for Rhodes grass by (Arshad *et al.,* 2014; and Rahman, 2007). The detailed qualitative comparisons of nutrients value in all eight cuts for different parameters are appended below in (Table 2).

Table 2. Effect of different watering treatments on qualitative parameters of Rhodes Grass.

Watering Treatment	Crude Protein (%)	Crude Fibre (%)	Ash (%)	Nitrogen Free Extract (%)	Ether Extract (%)
I_1	7.26c	26.88a	7.73a	46.73a	1.39a
I_2	9.77a	27.84a	7.89a	48.03a	1.25a
I_3	9.69a	27.79a	6.83a	45.08b	1.85a
I_4	8.04b	26.97a	7.95a	47.98ab	1.23a
I_5	6.75d	26.81a	8.16a	46.83ab	1.16a

Means followed by different letter shows significant result at 5% level of significance.

CONCLUSION

As a consequence of subject study it can be concluded that most of the growth parameters were significantly influenced by different watering treatments. Rhodes Grass plant height was significantly taller under the medium watering interval i.e. for I_2 (125.38 cm) and I_3 (116.88 cm) almost at all occasion. However, I_2 showed high yielding results for all the agronomic parameters i.e. maximum tillers / plant (4.86), leaves / tillers (10.13), leaf area (307.05 cm^2), green fodder yield (22.35 ton/ha/cut), and crude protein content (9.77) respectively. I_2 also produced highest (6.41 ton/ha/cut) dry fodder yield per hectare per cut. Statistical analyses of all the research parameters are elaborated in Table 01 and Table 02 respectively. Too early or late watering reduced the yield and yield parameters of Rhodes grass. From the obtained statistical results it can be concluded that the I_2 (10 days watering interval) perform better and hence it is recommended that this irrigation interval are best suited to cultivate Rhodes grass in the arid region of Tando Adam, Sindh – Pakistan. However, further investigations are necessary to establish the present findings in other regions of Pakistan as the seed variety (fine-cut) was used in this study therefore; results may vary for other type of seed varieties.

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CONFLICT OF INTEREST

There is no conflict of interest.

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