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Effect of different levels of Irrigation on the Growth and Yield of Rhodes Grass (*Chloris gayana* L. Kunth.) under the Agro-Climatic Conditions of Multan, Pakistan

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Abstract:
In a replicated field trial the effect of different levels of irrigation viz. (I_1 = 5 days, I_2 = 10 days, I_3 = 15 days, I_4 = 20 days, and I_5= 25 days) on a different Rhodes grass varieties, was investigated on a sandy clay loam soil during the year (2017 - 2018) in available agro-ecological conditions of Dogar Agricultural Farms in Multan, Punjab – Pakistan. The results showed that the treatment I_2 (irrigation interval 10 days) gives the overall higher yielding results for all the economic parameters and Fine cut, was the most suitable variety for this treatment which produced highest (7.09 ton/ha/cut) dry fodder yield per hectare per cut. The maximum plant height (138.58 cm), tillers / plant (2.38), leaves / tillers (11.19), leaf area (339.37 cm^2), and green fodder yield (24.71 ton/ha/cut) respectively. However, the other Rhodes grass varieties showed less yielding results for all the agronomic parameters for different irrigation treatments. Hence it is recommended that Fine cut variety is best suited to cultivate in the arid region of Makhdum Rasheed, Punjab – Pakistan with the irrigation interval of 10 days. Too early or late water application will be a wasteful and uneconomical practice.
Keywords: Rhodes Grass, Nitrogen Fertilizer, Irrigation, Agriculture, Multan, Pakistan.

INTRODUCTION

The fodder production in Pakistan 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 more than 2.7 M ha of cultivated area is utilized for fodder production (Muhammed, 2009). Rhodes grass is an important multi-cut and multi-tillering annual fodder. Green fodder in hay form is much more popular around the globe especially in UAE and Gulf Regions. And among all fodder grasses the Rhodes grass (Chloris Gayana. L. Kunth.); is becoming popular with every passing day (Arshad *et al.,* 2014). It is suitable for silage and hay like by all kinds of stock but may causes skin trouble in horses. Rhodes grass has high protein value (9 – 12%) and the average water consumption for Rhodes grass production is about 600 mm to 1200 mm. Arid regions where summer comes early the Rhodes grass sowing can be done from March to April and August to September (Valenzuela *et al.,* 2002).

Fertilizer and irrigation is the most important input that contributes to the yield, growth and to the quality improvement of the annual forage plants. It has been observed from past studies that Rhodes grass responded well to nitrogen fertilizer after a basic pre-plant phosphorous application (Arshad *et al.,* 2006). Furthermore, response of Rhodes grass was remarkable when Nitrogen fertilization was applied in a separate split dose (Rehman, 2007). By increasing the Nitrogen fertilizer, the leaf area and leaf to stem ratio of Rhodes grass also increase (Arshad, 2015). Fertilizers treatment had a very significant effect on fodder yield (fresh and dry), compared to control in Sorghum (Qamar *et al.,* 2000). On time irrigation play a very important role to enhance the fodder production and quality and quantity of Rhodes grass (Arshad *et al.,* 2016). Considering the above facts, the present investigation was conducted at Multan – Pakistan by focusing the Rhodes grass response to various levels of irrigation in available agro-ecological conditions.

MATERIALS AND METHODS

Location

The present study was conducted in the arid region of Multan in (Dogar Agricultural Farms) located at 8 km distance from Makhdum Rasheed Village Punjab – Pakistan in April (2017 / 2018). The soil of the agricultural farm was sandy clay loam in texture, with hydraulic conductivity (1.119×10^{-4} m/sec), bulk density (1.4 g/cm^3), and porosity (0.44) respectively. The total farm area was comprised of about 100 acres from which 15acres was cultivated with wheat and 35 acres with mango orchard and remaining 50 acres was kept for Rhodes grass cultivation accordingly.

Field Experimental Procedure

The experiment was laid out in a randomized complete block design (RCBD) with four replications. Thus, the total numbers of plots were twenty and the size of each plot was (5m x3m). In initial step the weeds and extra grass were cleared by using two split crosswise cultivator operations supplemented with disk plow to ensure uniform distribution of irrigation water. The land was then rough leveled by tractor with front and rear blade. 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 (Arshad *et al.,* 2014). Then cow dung was mixed by the help of tractor with front and rear blade and left for 3 days. After leveling pre- irrigation of 1 inch / acre of irrigation water was supplied 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 20 small plot of (15 m^2) area each was prepared.

Five commercial Rhodes grass cultivars sourced from Australia i.e. Pioneer, Katambora, Finecut, Callide, and Topcut was sown at the rate of 10kg per acre on (April 15, 2017) and Phosphorous fertilizer (DAP) dose applied at sowing accordingly. The watering treatments comprised of five different irrigation levels i.e. (I_1 = 5 days, I_2 = 10 days, I_3 = 15 days, I_4 = 20 days, and I_5= 25 days) respectively (Table 1). 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 (Mirza *et al.,* 2002). Altogether five cuts at 50% flowering stage were obtained during the study period. 20 plants were selected at random in each plot at 50% flowering stage for cutting the Rhodes grass crop for fodder purpose. The economic parameters studied during the research was plant height, tillers / plant, leaves / tillers, leaf area, green fodder yield, and dry matter yield respectively. All the collected data were subjected to analysis of variance; to test the superiority of treatment mean LSD test was applied by using a Microsoft computer package "MSTATC".

Table 1. Layout Plan of the Experiment.

I_1		I_2		I_3		I_4
I_5		I_2		I_4		I_1
I_4		I_1		I_2		I_3
I_1		I_3		I_5		I_2
I_3		I_5		I_4		I_5
MAIN CHANNEL						

RESULTS AND DISCUSSION

The present research study was carried out to check the performance of Rhodes grass yield and growth rate for five different varieties. The outcome of the study revealed that Rhodes grass plant height, tillers / plant, leaves / tillers, leaf area, green fodder yield and dry matter yields; differed very significantly at ($P \leq 0.05$) as shown in Table 2 to Table 6 respectively.

Economic Characters Studied for Rhodes Grass

Plant Height

The response of the different varieties to the plant height was found highly significant as the overall lowest plant height was observed in Callide (112.00 cm) followed by the Topcut (113.50 cm) for treatment I_5 respectively. However, the overall highest plant height was attained by Finecut (138.58 cm) followed by the Katambora (133.30 cm) for the treatment I_2 and I_4respectively. Similar results were obtained for plant height for Rhodes grass by (Yousif et al., 2012), who also observed the variation in Rhodes grass cultivars for the plant height.

Tillers / Plant

Different varieties response to the tillers per plant was observed highly significant. The overall lowest tillers per plant was observed in Topcut (4.15) followed by the Calide (4.27) for the treatment I_5 and I_4 respectively. However, the overall highest tillers per plant was attained by Finecut (5.38) followed by the Katambora (5.23) for the treatment I_2respectively. These results were according to the observation of (Ali et al., 2001), who also observed the variation in Rhodes grass cultivars for the tillers per plant.

Leaves / Tiller

The analysis of variance indicated that all varieties were highly significant ($P < 0.05$) for the leaves per tiller. Once again the overall highest leaves per tiller was attained by Finecut (11.19) followed by the Katambora (10.77) for the treatment I_2 and I_4respectively. However, the lowest leaves per tillers were observed in Topcut (8.93) for the treatment I_5respectively. The statistical analysis showed that these cultivars were statistically same for this trait. Similar results were recorded by (Saad, 2010) during his research work on Rhodes grass cultivation.

Table 2. Effect of Irrigation level (I_1) on the quantitative parameters of different Rhodes Grass Varieties.

Rhodes Grass Varieties	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)
Pioneer	126.72b	4.52b	9.59b	307.48b	21.54b	5.79b
Katambora	123.54b	5.13a	9.94b	301.85b	20.74b	5.27c
Finecut	135.94a	5.27a	10.98a	332.91a	24.24a	6.95a
Callide	119.29bc	4.36c	9.38bc	296.25b	20.62bc	5.73b
Topcut	117.72c	4.66b	9.58b	288.78bc	18.20c	4.51bc

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

Table 3. Effect of Irrigation level (I_2) on the quantitative parameters of different Rhodes Grass Varieties.

Rhodes Grass Varieties	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)
Pioneer	129.18b	4.61b	9.78b	313.45a	21.96b	5.90b
Katambora	125.94b	5.23a	10.13b	307.71b	21.15b	5.38bc
Finecut	138.58a	5.38a	11.19a	339.37a	24.71a	7.09a
Callide	121.61c	4.44c	9.57c	302.00bc	21.02b	5.84b
Topcut	120.00cd	4.75bc	9.77bc	294.39c	18.55c	4.60c

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

Table 4. Effect of Irrigation level (I_3) on the quantitative parameters of different Rhodes Grass Varieties.

Rhodes Grass Varieties	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)
Pioneer	124.74b	5.18a	10.04b	304.78b	20.95b	5.32bc
Katambora	127.95b	4.57b	9.68b	310.46b	21.75b	5.84b
Finecut	137.26a	5.32a	11.09a	336.14a	24.47a	7.02a
Callide	120.45bc	4.40bc	9.47b	299.12b	20.82b	5.78b
Topcut	118.86c	4.70b	9.67b	291.58c	18.38c	4.56c

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

Table 5. Effect of Irrigation level (I_4) on the quantitative parameters of different Rhodes Grass Varieties.

Rhodes Grass Varieties	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)
Pioneer	121.14b	5.03a	9.75b	295.99b	20.34b	5.17c
Katambora	133.30a	5.17a	10.77a	326.44a	23.77a	6.82a
Finecut	124.26b	4.43bc	9.40b	301.51b	21.12b	5.68b
Callide	116.98bc	4.27c	9.20c	290.50bc	20.22b	5.62b
Topcut	115.43c	4.57b	9.39b	283.17c	17.85c	4.42d

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

Table 6. Effect of Irrigation level (I_5) on the quantitative parameters of different Rhodes Grass Varieties.

Rhodes Grass Varieties	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)
Pioneer	129.34a	5.02a	10.45a	316.75a	23.06a	6.62a
Katambora	120.57b	4.30c	9.12b	292.55b	20.49b	5.51b
Finecut	117.54b	4.88b	9.46b	287.20b	19.74b	5.02bc
Callide	112.00c	4.43bc	9.11b	274.76bc	17.32c	4.29c
Topcut	113.50bc	4.15d	8.93bc	281.87b	19.62b	5.45b

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

Leaf Area

The analysis of variance indicated that all varieties were highly significant ($P < 0.05$) for the trait leaf area. It has been observed that overall cultivar Finecut showed highest leaf area (339.37 cm^2) followed by Katambora (326.44 cm^2) for the treatment I_2 and I_4, and lowest leaf area was observed for Topcut (281.87 cm^2) for the treatment I_5 respectively. The statistical analysis showed that these varieties were statistically at par form each other for this trait. These results were according to the observations of the (Mirza et al., 2002).

Green Fodder Yield

All varieties showed the highly significant ($P < 0.05$) differences for the green fodder yield per hectare per cut. The overall maximum yield for green fodder per hectare was observed for the Finecut (24.71 ton/ha/cut) for treatment I_2, followed by Katambora (23.77 ton/ha/cut) for treatment I_4, while the lowest yield per hectare was observed for Callide (17.32 ton/ha/cut) for the treatment I_5respectively. Similar results were obtained for green fodder yield for Rhodes grass (Borhan et al., 2000).

Dry Fodder Yield

Different cultivars response to the dry fodder yield was observed highly significant. The overall lowest dry fodder yield per hectare observed in Callide (4.29 ton/ha/cut) followed by the Topcut (4.42 ton/ha/cut) for the treatment I_5 and I_4 respectively. However, the overall highest dry fodder yield per hectare was once again attained by Finecut (7.09 ton/ha/cut) for the treatment I_2 respectively. These results were according to the observation of (Brima, 2011), who also observed the variation in Rhodes grass cultivars for the dry fodder yield. The comparison of different Rhodes grass varieties are elaborated in Figures 1 to 6 respectively.

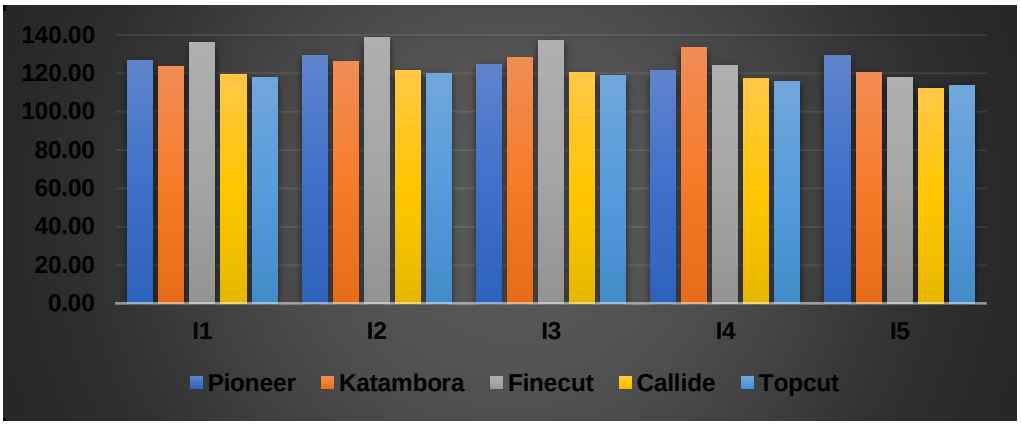

Fig. 1. Height of Plant (cm) for different Rhodes Grass Varieties at different Irrigation Levels.

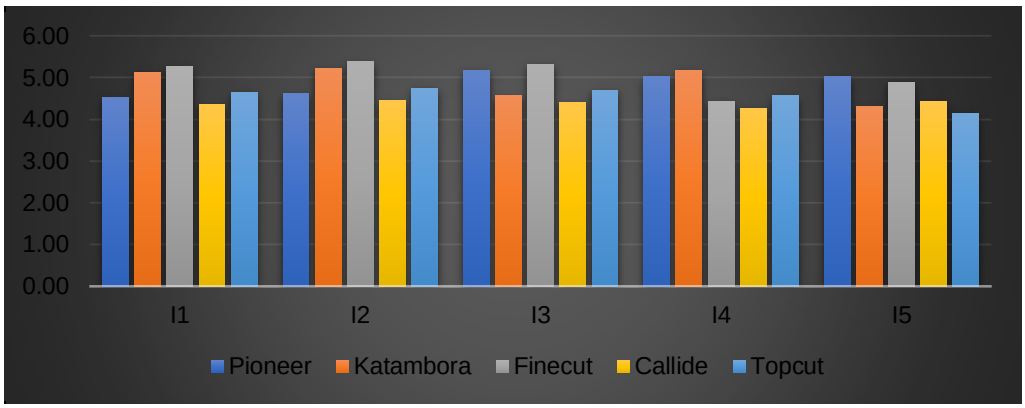

Fig. 2. Tillers per plant for different Rhodes Grass Varieties at different Irrigation Levels.

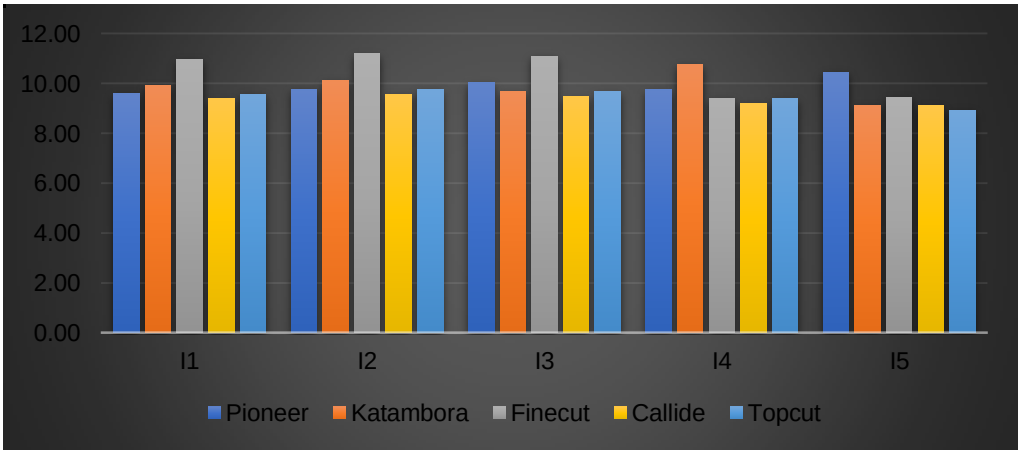

Fig. 3. Leaves per Tillers for different Rhodes Grass Varieties at different Irrigation Levels.

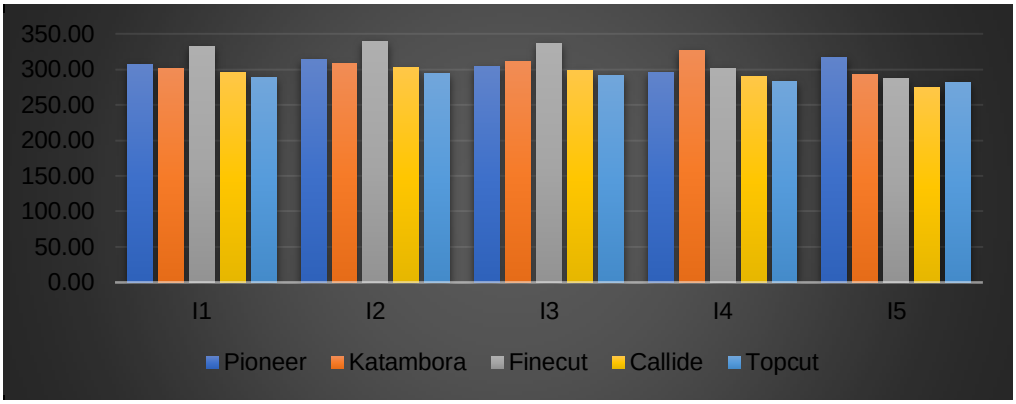

Fig. 4. Leaf Area (cm2) for different Rhodes Grass Varieties at different Irrigation Levels.

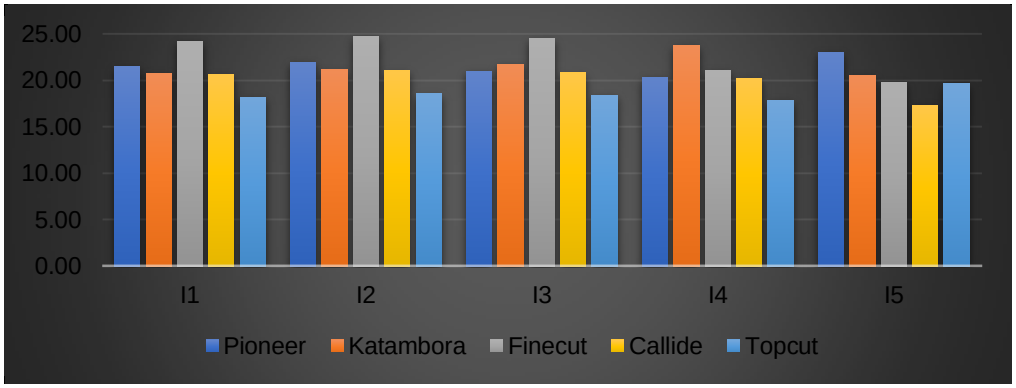

Fig. 5. Average Green Fodder Yield (ton/ha/cut) for different Rhodes Grass Varieties at different Irrigation.

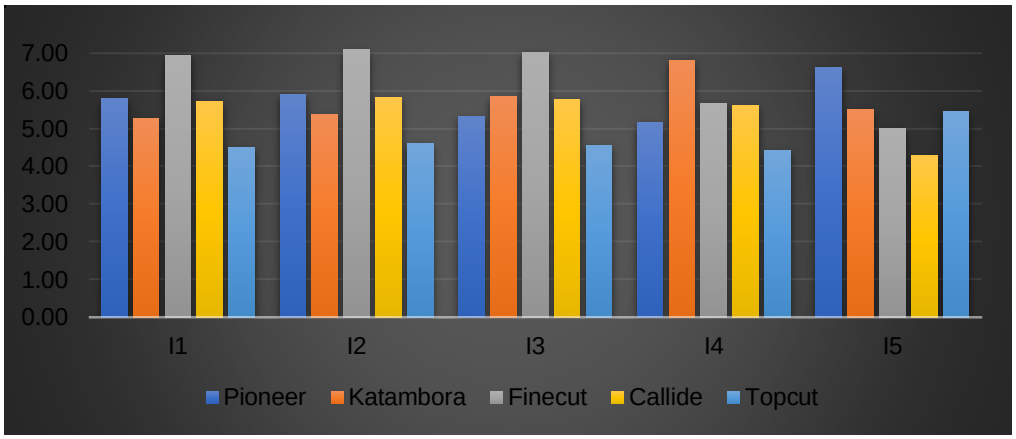

Fig. 6. Average Dry Fodder Yield (ton/ha/cut) for different Rhodes Grass Varieties at different Irrigation.

CONCLUSION

As a consequence of present research study, it can be concluded that different Rhodes grass varieties had a significant effect on the growth and yield of Rhodes grass. In a replicated field trial the economic parameters was studied and analysis of variance showed that the commercial varieties were significantly varied from each other. The treatment I_2(irrigation interval 10 days) gives the overall higher yielding results for all the economic parameters and Finecut was the most suitable variety for this treatment which produced highest (7.09 ton/ha/cut) dry fodder yield per hectare per cut. The maximum plant height (138.58 cm), tillers / plant (2.38), leaves / tillers (11.19), leaf area (339.37 cm^2), and green fodder yield (24.71 ton/ha/cut) respectively. However, the other Rhodes grass varieties showed less yielding results for all the agronomic parameters for different irrigation treatments. Hence it is recommended that Finecut variety is best suited to cultivate in the arid region of Makhdum Rasheed, Punjab – Pakistan with the irrigation interval of 10 days.

CONFLICT OF INTEREST

All the authors have declared that no conflict of interest exists.

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