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Effect of Irrigation Scheduling on Yield Components and Grain Yield of Two Nerica Varieties in MWEA Irrigation Scheme, Kenya

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ABSTRACT

Terrestrial heating is so real in Mwea that it has significantly reduced water levels in the canal; a catastrophe complexed with uphazard and unscheduling of irrigation in the scheme to the detriment of crops at its termini. In that view therefore, an experiment was set out at KALRO-Mwea to investigate on the effect of irrigation scheduling on yield components and grain yield of two Nerica rice varieties. The experiment was laid out in a Randomized Complete Block Design in split-plot arrangement replicated thrice. Four irrigation schedules (Daily (control), Every 3 days, Every 5 days and Weekly) formed main plots and two rice varieties (Nerica 4 and Nerica 11) formed the sub plots. Results indicated positive influence though not significant on filled grain number, shoot biomass, root biomass, unfilled grain number, productive tillers, panicle number, 1.5 m² plot grain weight, moisture content, and on grain yield in both seasons, while significant effect was exerted on 1000-grain weight, where highest and least 1000-grain weight of 55.92 g and 41.0 g in Nerica 4 on every 3 days and weekly schedules in season 1 were recorded respectively, while significant effect was elicited on unproductive tillers in season 2 where highest of 1.783 unproductive tillers in Nerica 11 on every 5 days' schedule was recorded, while least of 0.75 unproductive tillers in Nerica 4 on weekly schedule was also recorded. Positive though insignificant effect was also observed in unproductive tillers in season 1, while the same was observed in 1000-grain weight in season 2. Grain yield (ton/ha) did not present any significant effect due to irrigation schedule treatments in both seasons, although variation in means of grain yield was observed, where highest grain yield of 1.003 tons/hectare was produced in Nerica 4 on weekly irrigation schedule in season 2, while least grain yield of 0.863 tons/hectare was produced in Nerica 11 on every 3 days' irrigation schedule in both seasons. Nerica 4 outperformed Nerica 11 in productive tillers, 1.5 m² plot grain weight, 1000-grain weight and on grain yield, while Nerica 11 outperformed it in unproductive tillers, filled grain yield, unfilled grain yield, shoot biomass, root biomass, panicle number, and on moisture content in yield. Nerica 4 on weekly schedule, while Nerica 11 on control, and on every 5 days', and both on every 3 days' schedule are recommended to farmers for adoption.

1.0. Introduction

Rice (Oryza sativa, L) is a prime important lifestyle cereal crop in the Kenya's [1] contemporary society today than ever before. It is the third highly cultivated and utilized cereal crop in Kenya only after maize and wheat [2]. As a lifestyle food, many Kenyans across the settings magnificently consume it in various forms, yet its consumption levels are so high than are not met by production within the country, thereby leading to rice imports for purposes of meeting the ever-increasing national demands [3]. Truncated rice production remains extant due to countless factors [4] that include exaggerated moisture stress. Mwea irrigation scheme [5] has its crops in the field suffering perennial exaggerated moisture stress due to uphazard use of irrigation water in the Thibe river [6]. Such mismanagement and wastage of irrigation water requires scheduling [7] for availability of sufficient water to both nearby and far-away farms equally [3]. Such equal water-availability to all farms enables crops receive the required moisture to support their growth and development to successful yielding based on crop water requirement. Such yield-increment [8] would translate to upscaled food security [9], economic empowerment and improved living standards of farmers in Mwea irrigation scheme. Two Nerica varieties experimented on, were selected based on their superior traits [10] in arid and semi-arid agroecologies [11]. Mwea therefore falls in a semi-arid zone [3] where Nerica 11 and Nerica 4 are cultivated. However, information is scarce and limited on evaluating these Nerica varieties' [12] adaptation to irrigation scheduling [13] and how appropriate moisture levels [14] required influences their yield components and grain yield. In this view therefore, the study was carried out to determine on the effect of irrigation scheduling [15] on yield components and grain yield of two Nerica varieties in Mwea irrigation scheme.

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2.0. Materials and methods

2.1 Study Area

The study was conducted for two growing seasons at Mwea irrigation scheme's-Kirogo farm site [6] which lies at Latitude 0°37′ S 37˚20′E and at Longitude 0°32′ S and 0°46′ S [16], and at altitude of 1159 meters above sea level [17]. Its climate is tropical monsoon [18]. It has two rainy seasons and two dry seasons, with rain being of uneven distribution [19]. Temperature ranges from 15.6˚ c to 28.6˚c with a mean of 22˚ c. Soil types are classified as red soils with a slightly acidic pH of 6.18 [20], 0.119% N, 107.0% P (ppm) [21] and 0.085%K me/140g (Soil Survey for Mwea, 1992), while the exact farm site where the trial was set had its soil properties analyzed in the beginning and at the end of the two seasons.

2.2 Experimental design, materials, treatments, data collection and analysis

The experiments were carried out in RCBD with four irrigation schedules (Daily (control), Every three days, Every five days and Weekly) and two Nerica varieties (Nerica 4 and Nerica 11). Soil sampling and analysis was done before and after harvesting. The yield components and grain yield data were collected at harvest, measured and findings recorded. Collected data was cleaned and analyzed using GenStat version 15.1 and means separated using Fischer's Protected LSD test [22].

3.0 Results and Discussion

3.1 Effect of irrigation scheduling on yield components and grain yield of two Nerica varieties

The experimental results depicted significant effect ($P \leq 0.05$) on 1000-grain weight due to irrigation schedule treatments, but with no significant effect ($P > 0.05$) on filled grain number/hill, shoot biomass (gram/hill), root biomass (gram/hill), unfilled grain number/hill, productive tillers/ hill, unproductive tillers/hill, panicle number/hill, 1.5 m² plot grain weight (gram), moisture content (%)/hill, and 1000-grain weight (gram) in season 1. In season 2, only the yield component of unproductive tillers portrayed significant effects ($P \leq 0.05$) due to irrigation schedule treatments. The rest of the yield components that included filled grain number/hill, shoot biomass (gram/hill), root biomass (gram/hill), unfilled grain number/hill, productive tillers/hill, panicle number/hill, 1.5 m² plot grain weight (gram), moisture content (%)/hill, and 1000-grain weight (gram) did not have any significant effects ($P > 0.05$) as a result of irrigation scheduling treatment. Nevertheless, mean variation could still be observed in the results on analysis. In season 1, highest filled grain lot of 206.1/hill in Nerica 11 on every five days' irrigation schedule was recorded, while least filled grain lot of 141.9/hill in Nerica 11 on control irrigation schedule was also recorded. Highest shoot biomass of 25.57 gram/hill in Nerica 11 on control irrigation schedule was recorded, while least shoot biomass of 20.6 gram/hill in Nerica 4 on every three days' irrigation schedule was as well recorded. Highest root biomass of 17.74 gram/hill in Nerica 11 on control irrigation schedule was recorded, while least shoot biomass of 16.94 gram hill in Nerica 11 on every five days' irrigation schedule was also recorded. Highest unfilled grain lot / hill in Nerica 11 on every three days' irrigation schedule was recorded, while least of 149 unfilled grain lot in Nerica 4 on control irrigation schedule was recorded. Highest productive tillers of 13.5/hill in Nerica 11 on weekly irrigation schedule was recorded, while least number of 12.47 productive tillers in Nerica 4 on control irrigation schedule was recorded. Highest unproductive tillers of 1.42/hill in Nerica 11 on ever five days' irrigation schedule was recorded, while least number of 0.758 unproductive tillers in Nerica 11 on control irrigation schedule was recorded. Highest panicle number of 13.75/hill in Nerica 11 on control irrigation schedule was recorded, while least number of 0.867/hill in Nerica 4 on every five days' irrigation schedule was recorded. Highest 1.5 m² plot grain weight (gram) of 148.8 gram/hill in Nerica 11 on control irrigation schedule was recorded, while least 1.5 m² plot grain weight (gram) of 129.4 gram/hill in Nerica 4 on control irrigation schedule was recorded. Highest moisture content of 12.31% per split plot in Nerica 4 grains as a result of control irrigation schedule was recorded, while least of 11.22% per split plot in Nerica 11 grains on every five days' irrigation schedule was recorded. Finally, highest 1000-grain weight (gram) of 55.92 g/hill in Nerica 4 on every three days' irrigation schedule was recorded, while least 1000-grain weight of 41 g/hill in Nerica 4 on weekly irrigation schedule was recorded as illustrated in Table 3.1.1. In season 2, highest filled grain lot of 104.1/hill in Nerica 4 on every three days' irrigation schedule was recorded, while least filled grain lot of 78.0/hill in Nerica 4 still on weekly irrigation schedule was recorded. Highest shoot biomass of 0.225 g/hill in Nerica 11 plants on weekly irrigation schedule was recorded, while least shoot biomass of 0.158 g/hill in Nerica 4 on every five days' irrigation schedule was recorded. Highest root biomass of 0.225 gram/hill in Nerica 11 on weekly irrigation schedule was recorded, while least root biomass of 0.166 gram/hill in Nerica 4 on every five days' irrigation schedule was recorded. Highest unfilled grain lot of 17.85/hill in Nerica 11 on every five days' irrigation schedule was recorded, while least of 5.73 unfilled grain lot in Nerica 4 on control irrigation schedule was recorded. Highest productive tillers of 12.8 per hill in Nerica 11 on weekly irrigation schedule was recorded, while least number of 10.8 productive tillers in Nerica 4 on every five days' irrigation schedule was recorded. Highest unproductive tillers of 1.783/ hill in Nerica 11 on every five days' irrigation schedule was recorded, while least number of 0.75 unproductive tillers in Nerica 4 on every five days' irrigation schedule was recorded. Highest panicle number of 12.98/hill in Nerica 4 on weekly irrigation schedule was recorded, while least number of 8.58/hill in Nerica 11 on control irrigation schedule was recorded. Highest 1.5 m² plot grain weight (gram) of 150.4 gram/hill in Nerica 4 on weekly irrigation schedule was recorded, while least 1.5 m² plot grain weight (gram) of 129.5 g/hill in Nerica 11 on every three days' irrigation schedule was recorded. Highest moisture content of 13.01% per split plot in Nerica 11 grains as a result of every three days' irrigation schedule was recorded, while least of 11.93% per split plot with Nerica 11 grains on every three days' irrigation schedule still was recorded. Finally, highest 1000-grain weight (gram) of 20.5 g/hill in Nerica 4 on weekly irrigation schedule was recorded, while least 1000-grain weight of 19.29 g/hill in Nerica 11 as a result of weekly irrigation schedule treatment was recorded as illustrated in table 3.1.2. It was induceable that maximum filled grain lot of 206.1 was recorded in season 1, while least filled grain lot of 75.0 was recorded in season 2; the maximum shoot biomass of 25.57 gram/hill was recorded in season 1, while least of 0.158 gram/ hill was recorded in season 2; the maximum root biomass of 17.74 gram per hill was recorded in season 1, while least of 0.166 gram per hill was recorded in season 2; the maximum unfilled grain lot of 307 was recorded in season 1, while least of 5.73 was recorded in season 2; the maximum productive tiller number of 13.5 per hill was recorded in season 1, while least of 10.8 was recorded in season 2; the maximum and

least unproductive tiller number of 1.783 per hill and 0.75 per hill respectively were recorded in season 2; the maximum and least panicle number of 13.75 per hill and 0.867 per hill were recorded in season 1; the maximum 1.5 m² plot grain weight (gram) of 150.4 gram per hill was recorded in season 2, while the least of 129.4 was recorded in season 1; the maximum moisture content of 13.01% was recorded in season 2, while least of 11.22% was recorded in season 1, and lastly the maximum 1000-grain weight of 55.92 grams was recorded in season 1, while least of 19.29 grams was recorded in season 2. Grain yield (ton/hectare) did not present any significant effect as a result of irrigation schedule treatments in the two seasons. Nonetheless, variation in means of grain yield was observed, where highest grain yield of 1.003 tons per hectare was produced in Nerica 4 on weekly irrigation schedule in season 2, while least grain yield of 0.863 tons per hectare was produced in Nerica 11 on every three days' irrigation schedule in both seasons.

Table 3.1.1. Effect of irrigation scheduling on yield components and grain yield of two Nerica varieties in season 1.

Variety	Irrigation schedule	Filled grain	Shoot biomass	Root biomass	Unfilled grain	Productive tiller	Unproductive tillers	Panicle number	1.5 m² plot grain wt(g)	Moisture Content (%)	1000-grain wt(g)	Grain yield (t/ha)
Nerica 11	Daily	141.9a	25.57a	17.74a	237a	12.84a	0.758a	13.75a	148.8a	11.77a	43.58c	0.992a
	Every 3 days	161.1a	20.97a	17.57a	307a	12.55a	1.283a	1.283a	129.5a	12.26a	49.92a	0.863a
	Every 5 days	206.2a	21.96a	16.94a	156a	12.85a	1.417a	1.417a	137a	11.22a	48.95a	0.913a
	Weekly	174.5a	23.72a	17.62a	199a	13.5a	0.975a	0.975a	139.6a	11.99a	45.92b	0.931a
Nerica 4	Daily	143.4a	24.3a	17.42a	149a	12.47a	1.067a	1.067a	129.4a	12.31a	45.42b	0.863a
	Every 3 days	164.7a	20.6a	17.6a	201a	12.88a	0.925a	0.925a	131.1a	11.7a	55.92a	0.874a
	Every 5 days	185.9a	21a	17.68a	225a	12.92a	0.867a	0.867a	135.2a	11.98a	51.67a	0.902a
	Weekly	151.1a	22.29a	17.67a	243a	13.25a	1.008a	1.008a	140.3a	12.22a	41c	0.936a
	P value	0.957	0.999	0.822	0.159	0.905	0.109	0.109	0.557	0.27	0.018	0.557
	LSD	119.1	8.938	1.507	117.9	1.461	0.5317	0.5317	23.71	1	4.83	0.1581

Numbers with same letter in the same column are not significantly different using LSD at α=0.05.

Table 3.1.2. Effect of irrigation scheduling on yield components and yield of two Nerica varieties in season 2.

Variety	Irrigation schedule	Filled grain	Shoot biomass	Root biomass	Unfilled grain	Productive tiller	Unproductive tillers	Panicle number	1.5 m² plot grain wt(g)	Moisture Content (%)	1000-grain wt(g)	Grain yield (t/ha)
Nerica 11	Daily	86.1a	0.1628a	0.1837a	15.53a	10.48a	1.4a	8.58a	149a	12.38a	20.27a	0.993a
	Every 3 days	97a	0.1748a	0.2062a	14.32a	12.55a	1.6a	10.33a	129.5a	13.01a	20.04a	0.863a
	Every 5 days	94.6a	0.1602a	0.1922a	17.85a	11.07a	1.783a	10.53a	133.6a	11.93a	19.63a	0.891a
	Weekly	78a	0.2255a	0.2248a	10.42a	12.8a	1.017b	10.72a	142.8a	12.97a	19.29a	0.952a
Nerica 4	Daily	90.7a	0.1815a	0.1703a	5.73a	10.47a	1.533a	10.65a	131.9a	12.65a	20.31a	0.879a
	Every 3 days	104.1a	0.1605a	0.1744a	8.72a	10.3a	1.035b	10.88a	133.9a	12.83a	19.67a	0.893a
	Every 5 days	88.6a	0.1578a	0.1664a	15.05a	10.08a	0.75c	9.32a	132.1a	12.79a	20.02a	0.881a
	Weekly	93.5a	0.1857a	0.1919a	11.93a	10.83a	1.367a	12.98a	150.4a	12.68a	20.5a	1.003a
	P value	0.496	0.184	0.979	0.065	0.655	0.005	0.066	0.538	0.512	0.075	0.538
	LSD	19.78	0.03786	0.07109	5.975	2.755	0.5828	2.034	25.7	1.192	0.865	0.1713

Numbers with same letter in the same column are not significantly different using LSD at α=0.05.

Conclusion

Results indicated that there was positive influence though not significant as a result of irrigation scheduling on filled grain number, shoot biomass, root biomass, unfilled grain number, productive tillers, unproductive tillers, panicle number, 1.5 m² plot grain weight, moisture content, and grain yield in season 1, while significant effect was exerted on 1000-grain weight, where highest and least 1000-grain weight of 55.92 g and 41.0 g in Nerica 4 on every 3 days' and weekly irrigation schedules were recorded respectively. In season 2, the influence was insignificant on filled grain number, shoot biomass, root biomass, unfilled grain number, productive tillers, panicle number, 1.5 m² plot grain weight, moisture content, 1000-grain weight, and on grain yield, but proved significantly influential on unproductive tillers, where highest of 1.783 unproductive tillers in Nerica 11 on every 5 days' schedule was recorded, while least of 0.75 unproductive tillers in Nerica 4 on weekly schedule was also recorded. Grain yield (ton/ha) did not present any significant effect as a result of irrigation schedule treatments across the two seasons, although variation in means of grain yield was observed, where highest grain yield of 1.003 tons/hectare was produced in Nerica 4 on weekly irrigation schedule in season 2, while least grain yield of 0.863 tons/hectare was produced in Nerica 11 on every 3 days' irrigation schedule in both seasons. Nerica 4 outperformed Nerica 11 in productive tillers, unproductive tillers, 1.5 m² plot grain weight, 1000-grain–weight and on grain yield, while Nerica 11 outperformed it in filled grain yield, unfilled grain yield, shoot biomass, root biomass, panicle number, and on moisture content in yield. Nerica 4 on weekly schedule, while Nerica 11 on control, and on every 5 days, and both on every

3 days schedules are recommended to farmers for adoption. Lastly, It is therefore induceable that Nerica 4 is more drought tolerant and more adaptable to the arid conditions of Mwea irrigation scheme than Nerica 11, hence its survivability with no more addition of water for a week implies its ability to utilize moisture efficiently and effectively for proper physiological and metabolic processes to successful levels.

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This work was carried out in collaboration among all authors. Author EEM designed the study, wrote the protocol, wrote the first draft of the manuscript. Authors NKK, JPG and TEA reviewed the study design, and all drafts of the manuscripts. Author EEM undertook statistical analysis of the data collected. Author EEM managed the literature searches and reference-citations. Finally, all authors read and approved the final manuscript.

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