ISSN (Online): 2349-1183; ISSN (Print): 2349-9265
TROPICAL PLANT RESEARCH
The Journal of the Society for Tropical Plant Research

6(2): 183–191, 2019
DOI: 10.22271/tpr.2019.v6.i2.027

Research article

Growth response of two Nerica rice (*Oryza sativa* L.) varieties on irrigation scheduling in Mwea irrigation scheme, Kenya

Etabo Edung Mathew[1]*, N. K. Korir[1], J. P. Gweyi-Onyango[1] and T. E. Akuja[2]

[1]Department of Agricultural Sciences and Technology, Kenyatta University,
P O Box 43844-00100 Nairobi, Kenya
[2]School of Science-Turkana University College, P.O Box, 69-30500, Lodwar, Kenya

*Corresponding Author: mathewetabo@gmail.com
[Accepted: 25 June 2019]

Abstract: Mwea irrigation scheme presents itself as the most hard-hit with climate change impacts particularly drought; Mwea is endowed with modern irrigation infrastructure for rice production, though the watering practice meant to equitably allow every farm with crops to access water effectively and efficiently. In order for all crops in every farm to benefit equitably from such irrigation, therefore, watering of crops in the farms needs scheduling. In that view, therefore, an experiment was set out at KALRO-Mwea to investigate the effect of irrigation scheduling on growth parameters of two Nerica rice varieties. The experiment was laid out in a Randomized Complete Block Design in split-plot arrangement replicated thrice. It was justifiable to adopt this design for purposes of controlling variation in the experiment taken through taking account of spatial effects in the experimentation. Two rice varieties (Nerica 4 and Nerica 11) formed the main plots and four irrigation schedules (Daily, Every 4 days, Every 5 days and Weekly) formed the sub plots. Results indicated that the treatments significantly influenced plant height, fresh leaf weight, dry leaf weight, chlorophyll content, panicle length and panicle number of the two Nerica varieties at maturity. On the basis of research findings, it is recommended to the farmers in Mwea that the Nerica 4 on every 3 days and weekly irrigation schedules will be the best method to adopt.
Keywords: Mwea - Rice - Irrigation - Scheduling - Nerica - Growth response.

[Cite as: Mathew EE, Korir NK, Gweyi-Onyango JP & Akuja TE (2019) Growth response of two Nerica rice (*Oryza sativa* L.) varieties on irrigation scheduling in Mwea irrigation scheme, Kenya. *Tropical Plant Research* 6(2): 183–191]

INTRODUCTION

Rice (*Oryza sativa* L.) is the most consumed food crop in third world countries (Dowling *et al.* 1998). In Kenya, It is a lifestyle food whose consumption rates only after maize and wheat (Kouko *et al.* 2006). As a lifestyle food, many Kenyan populations utilize it across the socio-economic settings (Kimani et al. 2011) although the in-country production does not meet the utility needs, thus resorting to importation mostly from giant Asian nations' producers in an effort to meet the ever sky-rocketing rice demands in Kenya. Stressed production, therefore, is attributable to both abiotic and biotic factors (Chen & Murata 2002) that include water management and exaggerated moisture stress respectively. The earlier affects the latter, which would derail and limit the growth of crops. Limited growth would detrimentally affect maturity and crop yield ultimately. This is, therefore, the case for the Mwea irrigation scheme. Mwea irrigation scheme (Jaetzold *et al.* 2005) has its crops in the field suffering perennial exaggerated moisture stress due to haphazard use of irrigation water (Momo 2013) in Thibe river (Jaetzold *et al.* 2006). Such mismanagement and wastage of irrigation water require scheduling (Akinbile *et al.* 2007) for the availability of sufficient water to both nearby and far-way farms equally (Momo 2013). Such equal water-availability to all farms enables crops to receive the required moisture to support their growth to maturity and to ultimate yielding. Such yield-increment would enhance food security, promote good health and vibrate the economy of Mwea (Etabo *et al.* 2018). Considering, the arid and semi-arid agroecology of Mwea (Jaetzold *et al.* 2006) and the adaptability of a wider range of Nerica cultivars to such agroecological conditions, where their performance has been observed for some time to be good, owing to their drought-resistance and high water-use efficiency attributes (Fujii *et al.* 2006), yet insignificant information on

Received: 06 November 2018 Published online: 30 June 2019
https://doi.org/10.22271/tpr.2019.v6.i2.027

growth response of Nerica varieties to irrigation scheduling is available. Therefore, investigating on how the four irrigation schedules exert influence over two Nerica varieties is justifiable since plant growth variables demonstrate the performance of these given varieties to maturity.

MATERIALS AND METHODS

Study area

The study was conducted for two growing seasons in Mwea irrigation scheme (Jaetzold *et al.* 2006) which lies at Latitude 0° 37′ S, 37° 20′ E and at Longitude 0° 32′ S, 0° 46′ S (Nyang'au *et al.* 2014), and at altitude of 1159 meters above sea level (Takahashi *et al.* 2004). Its climate is tropical monsoon (Sambroek *et al.* 1982). It is characterized with bimodal rain season with two dry seasons. Rain is unevenly distributed throughout the year. Temperature ranges from 15.6ºC to 28.6°C with a mean of 22°C. Soils are red eutric-dystric vertisols with a slightly acidic pH of 6.18 (Matsunami *et al.* 2009), 0.119% N, 107.0% P (Weeda 1987) and 0.085% K (Somado *et al.* (2008). These loamy clay soils with such near neutral pH are suitable for rice farming, and that is why Mwea irrigation scheme in Kenya is home to rice farming.

Experimental design, materials, treatments, data collection and analysis

The experiments were carried out in RCBD with the split-plot arrangement (Kanyanjua *et al.* 2002) with four irrigation schedules (Daily, Every three days, Every five days and Weekly) and two Nerica varieties (Nerica 4 and Nerica 11). Soil sampling and analysis were done before and after harvesting. Data were collected in both seasons from week 4, 7,10,13,16 on plant height, tiller number, leaf number, leaf fresh weight, leaf dry weight, and SPAD readings. Collected and recorded data were cleaned and analyzed using GenStat version 15.1 (Payne 2009) and means separated using Fischer's Protected LSD test (Gary 2010).

RESULTS AND DISCUSSION

Plant height

Results revealed that there was a significant effect ($P \leq 0.05$) on plant height due to irrigation scheduling for Nerica 4 and 11 varieties in week 16 and 19, but no significant effect ($P > 0.05$) was exhibited by rice plants in weeks 4, 7, 10 and 13 during season one. In week 16, both Nerica 11 and 4 recorded highest height of 59.52 cm and 60 cm respectively in every three days' irrigation schedule treatment and least of 56.27 cm and 57 cm at daily irrigation schedule respectively. In week 19 also, Nerica 11 and 4 recorded highest height of 63.52 cm and 64.29 cm respectively on every three days' irrigation schedule treatment and lowest of 60.27 cm and 61.82 cm on daily irrigation schedule respectively. In Nerica 11, minor difference in plant height was observed, with the highest being at irrigation schedule of every three days (14.88 cm) and least on that of daily (12.04 cm) in week 4. In week 7, plant height was highest and least on weekly (28.65 cm) and on every five days' (23.92 cm) irrigation schedules respectively. In week 10, plant height ranged from 32.9 cm to 36.59 cm with highest being recorded on every three days' irrigation schedule and lowest on every five days, and in week 13, highest plant height was recorded on every three days (48.27 cm), while lowest on daily irrigation schedule (42.42 cm). In regard to Nerica 4, a consistent trend was observed in weeks 4, 10, 13, 16 and 19 in which mean variation though non-significant, presented highest and least mean values being recorded on every three days (14.88 cm, 34.05 cm, 48.5 cm, 60 cm and 64.29 cm) and on daily irrigation (12.81 cm, 29.85 cm, 43.03 cm, 57 cm and 61.82 cm) schedules respectively. Finally, in week 7, plant height was highest and lowest on every three days' (27.0 cm) and on every five days' (21.5 cm) irrigation schedules respectively. The daily irrigation in Nerica 11 as compared to other irrigation schedules influenced the development of grains from milk stage through the dough to mature stage, and such growth process increased plant height with no contradiction. Such is consistent with Pal *et al***.** (2013) who in their irrigation scheduling on scented rice in India found out that a one day schedule as compared to the four-day and seven-day schedules, resulted into higher plant height, leaf area index and dry matter/plant. Plant height was higher at every three days' irrigation schedule at tillering, panicle initiation, heading, flowering and at the formation of grain stages in comparison to other three irrigation schedules. The irrigation schedule of every three days' recorded higher plant height at tillering, stem-elongation, panicle-initiation, heading, flowering, grain-formation on Nerica 4 plants as compared to other three irrigation schedules, although the weekly irrigation schedule also had an influence on increment in plant height at maturity to harvest. In season 2, results revealed that, there was a significant effect ($P \leq 0.05$) on Nerica varieties due to irrigation scheduling in week 19 in which highest plant height of 66.8 cm and 68.7 cm were recorded in every three days' irrigation schedule in Nerica 11 and 4 respectively, while least of 63.1 cm and 64.2 cm in Nerica 11 and 4 respectively on daily irrigation schedule. There was no significant effect ($P > 0.05$) due to irrigation

scheduling observed in the rest of the weeks, though mean plant height variation was manifest as follows: In week 4, both highest and lowest plant heights of 17.4 cm and 12.08 cm in Nerica 11 and 4 plants respectively were recorded under every three days' irrigation schedule; In week 7, highest plant height of 26.42 cm and lowest of 23.17 cm in Nerica 11 plants under every three days' and daily irrigation schedules respectively were recorded; In weeks 10 and 13, highest plant heights of 41.25 cm and 58.6 cm in Nerica 11 plants under every three days' irrigation schedule were recorded, while lowest plant heights of 35.5 cm and 49.9 cm in Nerica 4 plants under daily irrigation schedule were recorded; and lastly, in week 16, highest and lowest plant heights of 65 cm and 60 cm in Nerica 4 plants under every three days' and on daily irrigation schedule respectively were recorded (Fig. 1).

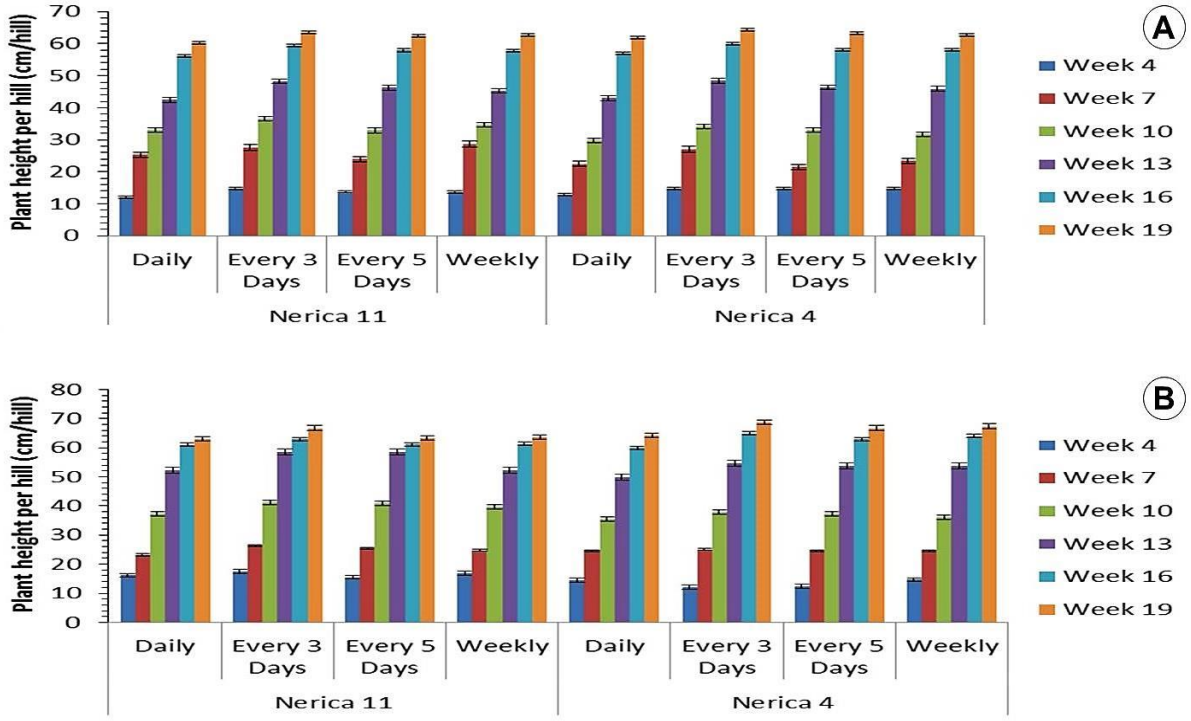

Figure 1. Effect of irrigation scheduling on plant height of two Nerica varieties in: **A**, Season 1; **B**, Season 2.

Leaf number

Results revealed that there were no significant effects (P>0.05) exhibited in leaf number due to irrigation scheduling in both Nerica 11 and 4 throughout the crop's life in both seasons as it is illustrated in table 1. In week 4 (tillering), highest leaf number was recorded due to every three days' irrigation schedule (5.87 per hill), and lowest on daily irrigation schedule (4.6 per hill) in Nerica plants. In week 7 (stem elongation), highest and lowest leaf numbers of 11.22 per hill and 8.57 per hill respectively were elicited in Nerica 11 plants on weekly and on daily irrigation schedules respectively. In week 10 (panicle initiation and heading), highest and lowest leaf numbers were recorded on daily (23.91 per hill) and on every three days' (21.32 per hill) irrigation schedules respectively in Nerica plants. In week 13(flowering and grain formation), highest and lowest leaf numbers were recorded on daily (27.04 per hill) and on weekly (25.42 per hill) irrigation schedules respectively in Nerica plants. In week 16 (maturity), highest leaf number of 29.32 per hill was recorded on daily irrigation schedule, while lowest of 26.13 per hill on weekly irrigation schedule in Nerica plants, and in week 19 (harvest), highest and lowest leaf numbers were recorded on daily (29.13 per hill) and on weekly (26.13 per hill) irrigation schedules respectively in Nerica plants. In season 1, Nerica 11 plants' foliage production outperformed Nerica 4 throughout under the daily irrigation schedule. Maximum leaf number was produced in week 16 (maturity) that slightly dropped at physiological maturity (week 19). That was the most critical stage when the tested crops needed enormous water-amounts and therefore those Nerica 11 plants that received the daily irrigation schedule treatment had the higher proliferation of leaves observed than Nerica 4 plants that had produced slightly lower leaves under the irrigation schedule of every three days (Table 1). Numerous number of leaves increased photosynthetic sites for food formation, leading to translocation of photosynthates to panicles where grains would form after autotrophism. In season 2, highest leaf number of 13 per hill, 21.25 per hill, 23 per hill, 25.2 per hill, 27.2 per hill and 27.2 per hill were produced in Nerica 4 plants in weeks 4,7,10,13,16 and 19 respectively, while lowest of 8.75 per hill, 15.92 per hill, 18.75 per hill, 21.75 per hill, 23.75 per hill and 23.75

per hill were produced in Nerica 11 plants in weeks 4,7,10,13,16 and 19 respectively.

Table 1. Number of leaves for irrigation scheduling on two Nerica varieties.

Variety	Irrigation schedule	Week 4	Week 7	Week 10	Week 13	Week 16	Week 19
Season 1							
Nerica 11	Daily	4.6a	9.2a	23.9a	27.0a	29.3a	29.3a
	Every 3 Days	5.9a	8.8a	21.3a	25.9a	27.2a	27.2a
	Every 5 Days	5.7a	10.7a	23.8a	25.5a	26.3a	26.3a
	Weekly	5.1a	11.2a	21.9a	25.4a	26.1a	26.1a
Nerica 4	Daily	4.7a	9.2a	22.3a	26.1a	28.8a	28.8a
	Every 3 Days	5.9a	9.7a	22.6a	26.4a	28.9a	28.9a
	Every 5 Days	5.0a	9.0a	21.5a	26.3a	27.5a	27.5a
	Weekly	4.6a	9.4a	22.3a	26.3a	27.9a	27.9a
	LSD	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Season 2							
Nerica 11	Daily	9.8a	16.8a	20.8a	23.2a	25.2a	25.2a
	Every 3 Days	10.3a	17.3a	21.3a	24.3a	26.3a	26.3a
	Every 5 Days	8.8a	16.4a	19.8a	22.8a	24.8a	24.8a
	Weekly	8.8a	15.9a	18.8a	21.8a	23.8a	23.8a
Nerica 4	Daily	9.2a	18.9a	22.2a	24.2a	26.2a	26.2a
	Every 3 Days	9.6a	16.5a	19.6a	22.6a	24.6a	24.6a
	Every 5 Days	13.0a	21.3a	23.0a	25.2a	27.2a	27.2a
	Weekly	9.8a	17.2a	21.8a	23.8a	25.8a	25.8a
	LSD	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Means followed by the same letter in a column are not significantly different at 95% confidence level

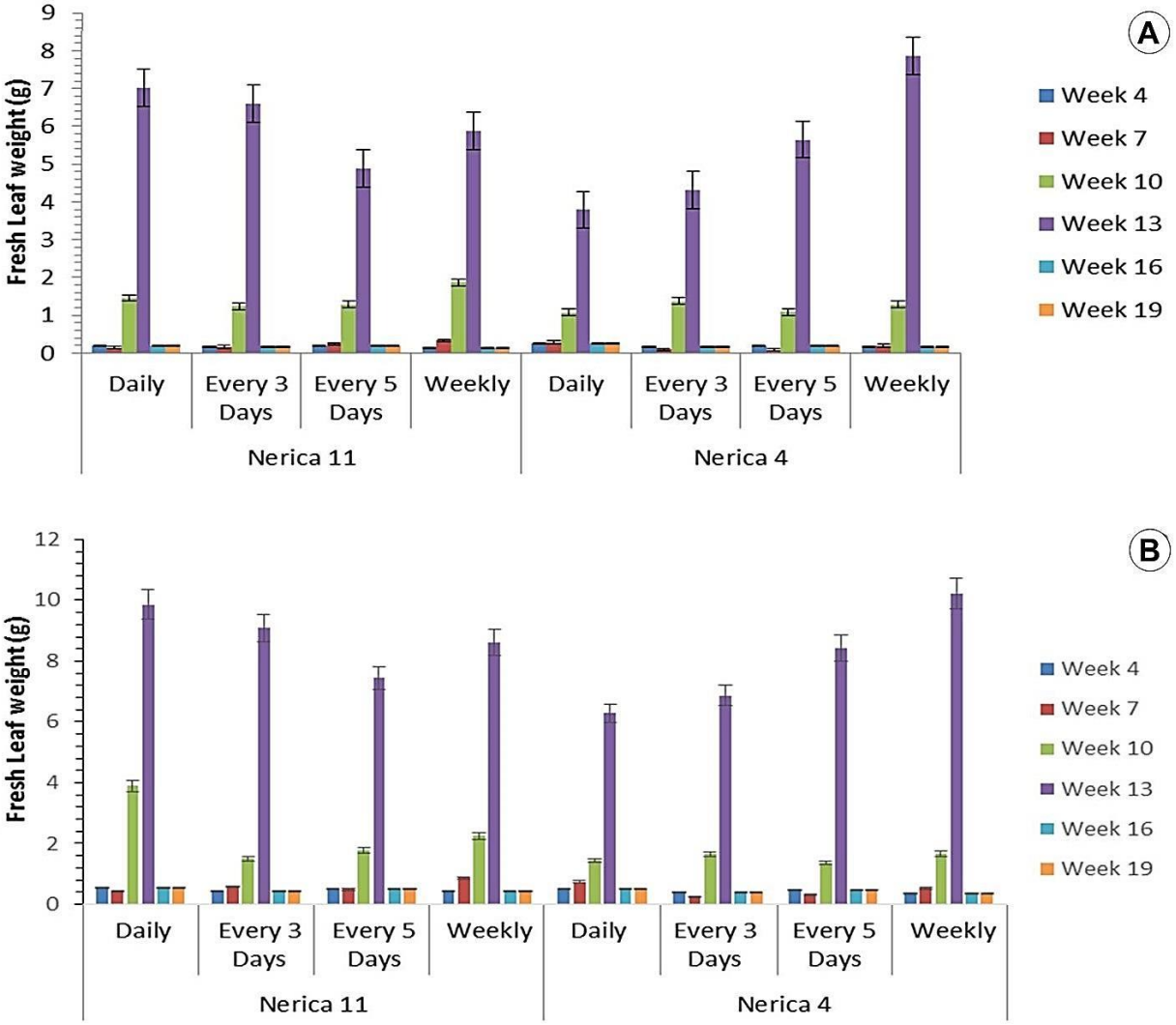

Figure 2. Effect of irrigation scheduling on fresh leaf weight of two Nerica varieties in: **A**, Season 1; **B**, Season 2.

Fresh leaf weight

Leaf fresh weight was significantly influenced ($P \leq 0.05$) by different irrigation scheduling treatments on Nerica 4 and 11 across the two seasons. Results showed that in week 4, highest leaf fresh weight of 0.547 g/hill in Nerica 11 plants on daily irrigation schedule was recorded in season 1, while lowest of 0.0568 g/hill in Nerica 4 plants on every three days' irrigation schedule was recorded in season 2. In week 7, highest leaf fresh weight of 0.737 g/hill in Nerica 4 plants on daily irrigation schedule was recorded in season 1, while lowest of 0.087 g/hill in Nerica 4 plants also on daily irrigation schedule was recorded in season 2. In week 10, highest leaf fresh weight of 3.89 g/hill in Nerica 11 plants on daily irrigation schedule was recorded in season 1, while lowest of 0.129 g/hill in Nerica 4 plants was recorded on every three days' irrigation schedule in season 2. In week 13, highest leaf fresh weight of 10.22 g/hill in Nerica 4 plants on weekly irrigation schedule was recorded in season 1, while lowest of 0.273 g/hill in Nerica 4 plants were recorded on every three days' irrigation schedule in season 2. In week 16, highest leaf fresh weight of 0.547 g/hill in Nerica 11 plants on daily irrigation schedule was recorded in season 1, while lowest of 0.365 g/hill in Nerica 4 plants were recorded on weekly irrigation schedule in season 1. Finally, In week 19, highest leaf fresh weight of 0.547 g/hill in Nerica 11 plants on daily irrigation schedule was recorded in season 1, while lowest of 0.319 g/hill in Nerica 4 plants were recorded on every three days' irrigation schedule in season 2. It is induceable that, optimum leaf fresh weight was elicited in Nerica 4 plants in season 1 under weekly irrigation schedule, while least was produced in season 2 in Nerica 4 plants under every three days' irrigation schedule as evidenced in figure 2.

Dry leaf weight

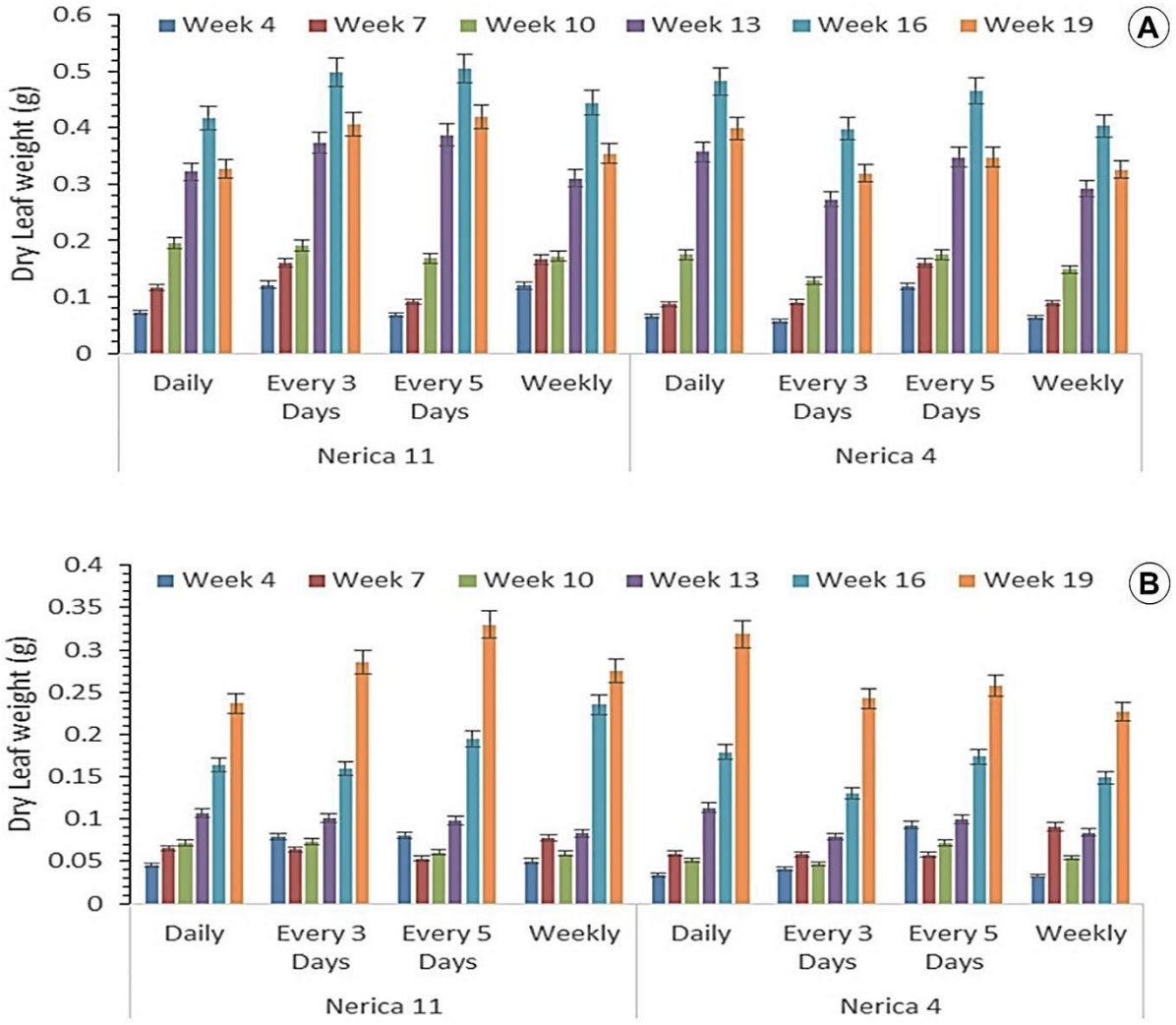

Figure 3. Effect of irrigation scheduling on leaf dry weight of two Nerica varieties in: **A**, Season 1; **B**, Season 1.

It is naturally true to attribute the difference in weight between leaf fresh weight and leaf dry weight to the loss of moisture content in the drying process, and that is the reason deter for leaf dry weight being lower than the leaf fresh weight. Results demonstrated that irrigation scheduling treatments significantly affected leaf dry

weight of the two Nerica varieties throughout the entire crops' life in the two seasons just as it did for the leaf fresh weight. Therefore in week 4, highest leaf dry weight of 0.242 g/hill in Nerica 4 plants on daily irrigation schedule was recorded in season 1, while lowest of 0.033 g/hill in Nerica 4 plants were recorded on weekly irrigation schedule in season 2. In week 7, highest leaf dry weight of 0.334 g/hill in Nerica 11 plants on weekly irrigation schedule was recorded in season 1, while lowest of 0.053 g/hill in Nerica 11 plants again was recorded on every five days' irrigation schedule in season 2. In week 10, highest leaf dry weight of 1.457 g/hill in Nerica 11 plants on daily irrigation schedule was recorded in season 1, while lowest of 0.0464 g/hill in Nerica 4 plants were recorded on every three days' irrigation schedule in season 2. In week 13, highest leaf dry weight of 7.86 g/hill in Nerica 4 plants on weekly irrigation schedule was recorded in season 1, while lowest of 0.0795 g/hill in Nerica 4 plants were recorded on every three days' irrigation schedule in season 2. In week 16, highest leaf dry weight of 0.242 g/hill in Nerica 4 plants on daily irrigation schedule was recorded in season 1, while lowest of 0.128 g/hill in Nerica 11 plants were recorded on weekly irrigation schedule in season 1. Finally, in week 19, highest leaf dry weight of 0.3298 g/hill in Nerica 11 plants on every five days' irrigation schedule was recorded in season 2, while lowest of 0.128 g/hill in Nerica 11 plants were recorded on weekly irrigation schedule in season 1. It was understood from the experiment that, optimum production of leaf dry weight was observed in week 13 in Nerica 4 plants under weekly irrigation schedule in season 1, while least leaf dry weight was produced in week 4 in Nerica 4 plants under weekly irrigation schedule in season 2 (Fig. 3).

Tiller number

Results revealed that there were no significant effects ($P>0.05$) exhibited in tiller number due to irrigation scheduling applied for Nerica varieties in weeks 4, 7, 10, 13, 16 and 19 in both season 1 and 2. Growth of tillers in rice occurred substantially between week 4 and week 13; a period within which tillering proves important in rice growth and development under normal circumstances. In season 1, week 4 recorded highest tiller number of 5.35 per hill in Nerica 4 plants on every three days' irrigation schedule, while lowest of 3.72 per hill was recorded in Nerica 11 plants under daily irrigation schedule. In week 7, highest tiller number of 6.575 per hill in Nerica 11 plants on every three days' irrigation schedule was recorded, while lowest of 5.375 per hill was recorded in Nerica 11 plants under daily irrigation schedule. In week 10, highest tiller number of 8.63 per hill in Nerica 11 plants on daily irrigation schedule was recorded, while lowest of 7.58 per hill was recorded in Nerica 4 plants under every three days' irrigation schedule. In week 13, highest tiller number of 12.08 per hill in Nerica 4 plants on weekly irrigation schedule was recorded, while lowest of 10.79 per hill was recorded in Nerica 4 plants under every three days' irrigation schedule. In week 16, weekly irrigation schedule elicited highest tiller number of 19.32 per hill in Nerica 4 plants, while lowest tiller number of 15.79 per hill was elicited in Nerica 4 plants on daily irrigation schedule. In week 7 and 4, where the number of tillers produced in Nerica plants was lowest and least respectively, the results resonated with the venerable argument advanced by Insalud *et al.* (2006) that, at submerged soil conditions, reduction in tiller number was observed (Table 2)**.** It was also induceable from the research that there were no significant reductions in tiller number due to water stress placed on some plants (Tantawi & Ghanem 2001) of the two varieties tested under every three days', every five days' and weekly irrigation schedules. Insignificant influence of moisture stress on the number of tillers at any stage of rice growth does not negatively affect rice grain yield, hence confirming the veracity of Momo's (Momo 2013) statement that, tiller proliferation in rice growth is one critical yield component that determines its yield at physiological maturity. In season 2, variation in mean of tiller number was manifested as follows; in week 4, highest tiller number of 3.58 per hill in Nerica 4 plants was recorded under every five days' irrigation schedule/weekly irrigation schedule, while lowest tiller number of 1.92 per hill in Nerica 4 plants was recorded under every three days' irrigation schedule. In week 7, highest tiller number of 6.5 per hill in Nerica 4 was produced on every five days' irrigation schedule, while lowest of 3.75 per hill in Nerica 4 was produced on every three days' irrigation schedule. In week 10, highest tiller number of 8.83 per hill in Nerica 4 plants were produced on every five days' irrigation schedule, while lowest of 5.67 per hill in Nerica 4 plants were produced on every three days' irrigation schedule. In week 13, the highest tiller number of 12.92 per hill in Nerica 4 plants were produced under weekly irrigation schedule, while the lowest of 10.17 per hill in Nerica 11 plants were recorded under weekly irrigation schedule. Finally, in week 16, highest tiller number of 14.58 per hill in Nerica 4 under weekly irrigation schedule, while the lowest of 12.08 per hill in Nerica 11 plants were produced under weekly irrigation schedule. From the experiment, it is inferential that, highest tiller number of 19.32 per hill in Nerica 4 plants was recorded under weekly irrigation schedule in season 1, whereas the least tiller number of 1.92 per hill in Nerica 4 plants under every three days' irrigation schedule in season 2 as evidenced in table 2.

Table 2. The number of tillers for irrigation scheduling.

Variety	Irrigation schedule	Week 4	Week 7	Week 10	Week 13	Week 16	Week 19
				Season 1			
Nerica 11	Daily	4a	5a	9a	11a	19a	19a
	Every 3 Days	5a	7a	8a	12a	18a	19a
	Every 5 Days	4a	6a	8a	12a	17a	19a
	Weekly	4a	6a	8a	11a	16a	19a
Nerica 4	Daily	4a	6a	8a	11a	16a	18a
	Every 3 Days	5a	7a	8a	11a	16a	19a
	Every 5 Days	5a	6a	8a	12a	19a	19a
	Weekly	5a	6a	8a	12a	19a	19a
	LSD	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
				Season 2			
Nerica 11	Daily	3a	5a	7a	11a	13a	13a
	Every 3 Days	3a	5a	8a	12a	14a	14a
	Every 5 Days	3a	4a	6a	11a	14a	14a
	Weekly	2a	4a	6a	10a	12a	14a
Nerica 4	Daily	2a	4a	7a	10a	12a	12a
	Every 3 Days	2a	4a	6a	13a	14a	14a
	Every 5 Days	4a	7a	9a	12a	13a	13a
	Weekly	4a	6a	8a	13a	15a	15a
	LSD	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: Means followed by the same letter in a column are not significantly different at 95% confidence level.

Chlorophyll content

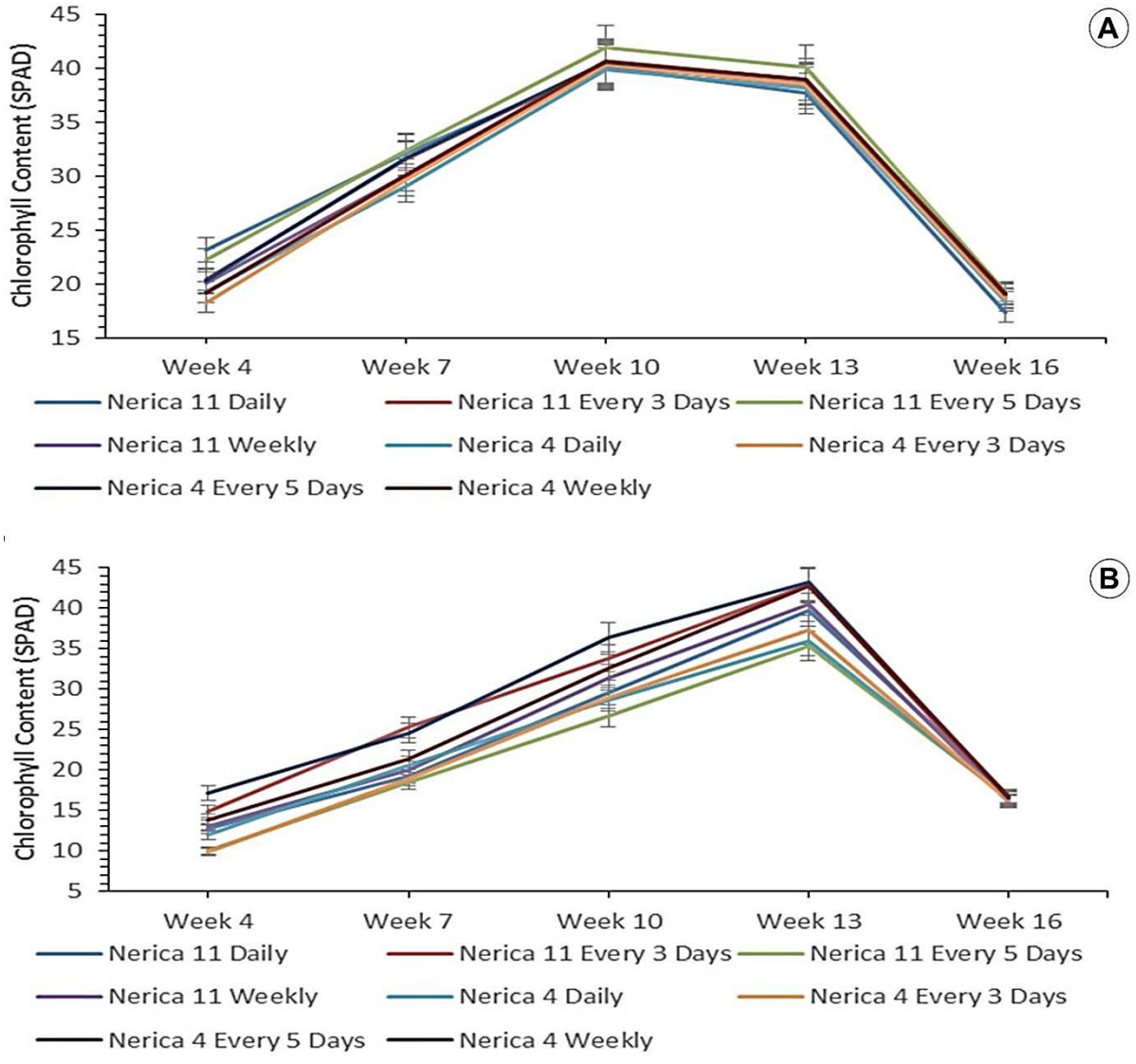

Figure 4. Effect of irrigation scheduling on chlorophyll content of two Nerica varieties in: **A**, Season 1; **B**, Season 2.

The experimental results in season 1 revealed that there was a significant effect (P≤0.05) in chlorophyll content due to irrigation scheduling treatments in both seasons. The significant differential response of the two varietal plants to irrigation scheduling was pretty visible in weeks 4, 7, 10, 13, and 16 after planting in season 1 as follows: in week 4, highest chlorophyll content of 23.17 SPADs per hill in Nerica 11 plants under daily irrigation schedule was recorded, while lowest of 18.3 SPADs per hill was recorded in Nerica 4 plants under every three days' irrigation schedule; in week 7, the highest chlorophyll content of 32.33 SPADs per hill in Nerica 11 plants under every five days' irrigation schedule was recorded, while lowest of 29.04 SPADs per hill was recorded in Nerica 4 plants under daily irrigation schedule; in week 10, the highest chlorophyll content of 41.87 SPADs per hill in Nerica 11 plants under every five days' irrigation schedule was recorded, while lowest of 39.88 SPADs per hill was recorded in Nerica 4 plants under daily irrigation schedule; in week 13, the highest chlorophyll content of 40.13 SPADs per hill in Nerica 11 plants on every five days' irrigation schedule was recorded, while lowest of 37.65 SPADs per hill was recorded in Nerica 11 plants under daily irrigation schedule and, finally in week 16, highest chlorophyll content of 19.28 SPADs per hill in Nerica 11 plants on every five days' irrigation schedule was recorded, while lowest of 17.31 SPADs per hill was recorded on Nerica 11 plants under daily irrigation schedule. In season 2, the differential influence was as follows: in week 4, the highest chlorophyll content of 17.14 SPADs per hill in Nerica 4 plants on every five days' irrigation schedule was recorded, while lowest of 9.85 SPADs per hill was recorded in Nerica 4 plants under every three days' irrigation schedule; in week 7, the highest chlorophyll content of 25.3 SPADs per hill in Nerica 11 plants under every three days' irrigation schedule was recorded, while lowest of 18.56 SPADs per hill was recorded in Nerica 11 plants under every five days' irrigation schedule; in week 10, the highest chlorophyll content of 36.45 SPADs per hill by Nerica 4 plants under every five days' irrigation schedule was recorded, while lowest of 26.67 SPADs per hill was recorded in Nerica 11 plants under every five days' irrigation schedule; in week 13, the highest chlorophyll content of 43.19 SPADs per hill in Nerica 4 plants under every five days' irrigation schedule was recorded, while lowest of 35.37 SPADs per hill was recorded in Nerica 11 plants under every five days' irrigation schedule and lastly, in week 16, highest chlorophyll content of 16.79 SPADs per hill in Nerica 11 plants under daily irrigation schedule was recorded, while lowest of 16.08 SPADs per hill was recorded in Nerica 11 plants under every three days' irrigation schedule. It was demonstrated that optimum chlorophyll content production was elicited in week 13 in Nerica 4 plants under every five days' irrigation schedule in season 2, while least chlorophyll content production was elicited in week 4 in Nerica 4 plants under every three days' irrigation schedule in season 2 too as evidenced in figure 4.

CONCLUSION

The experimental results indicated that the irrigation schedule treatment applied significantly influenced plant height, fresh leaf weight, dry leaf weight, chlorophyll content, panicle length and panicle number of the two Nerica varieties at maturity age, where highest plant height of 68.7 cm per hill in Nerica 4 on every 3 days in season 2, while least of 60.27 cm per hill in Nerica 11 on control in season 1 were recorded. Fresh leaf weight of 0.547 g/hill in Nerica 11 on the control in season 1 and least of 0.319 g/hill in Nerica 4 on every 3 days' irrigation schedule in season 2 were recorded. Highest dry leaf weight of 0.3298 g/hill in Nerica 11 on every 5 days' irrigation schedule was recorded in season 2, while least of 0.128 g/hill in Nerica 11 was recorded on weekly irrigation schedule in season 1. Optimum (43.19 SPADs per hill) chlorophyll content production was elicited in week 13 in Nerica 4 under every 5 days' irrigation schedule in season 2, while least (9.85 SPADs per hill) chlorophyll content production was elicited in week 4 in Nerica 4 under every 3 days' irrigation schedule in season 2. Highest panicle length of 20.45 cm per hill in Nerica 11 under daily irrigation schedule and least of 13.54 cm per hill were recorded in Nerica 4 under daily irrigation schedule in season 1. Highest panicle number of 17.33 per hill in Nerica 11 on every 5 days in season 1 and least of 8.58 per hill on the control in season 2 were recorded. Though the influence was insignificant on leaf number and tiller number, variation in mean values was exhibited, where highest mean value of 29.13 leaves/hill at maturity of the crop was recorded in both cultivars on control in season 1, while least of 23.8 leaves/hill was recorded in Nerica 11 on weekly irrigation schedule in season 2. Lastly, highest tiller number of 19.32 per hill in Nerica 4 under weekly irrigation schedule in season 1, and least tiller number of 12 per hill in Nerica 4 under control in season 2 were also recorded. Finally, It is induceable that Nerica 4 outperformed Nerica 11 in chlorophyll production, plant height and tiller growth, while Nerica 11 outperformed Nerica 4 in panicle number, panicle length, fresh and dry leaf weight, and both varieties responded at the same level in leaf growth and production. Lastly, Nerica 4 on every 3 days' and on weekly schedules, and both varieties on control and on every 5 days' are recommended for adoption by

Mwea farmers.

ACKNOWLEDGEMENTS

We acknowledge the KALRO center director Dr.Kimani Jimmy who offered land where this experimental research was undertaken and for the data assistants including Mr.Gichuki Kimani for good data collection. In addition, authors have declared that no competing interests exist in this work.

REFERENCES

Akinbile CO, Sangodoyin AY & Nwilene FE (2007) Growth and Yield Responses of Upland Rice (NERICA) under Different Water Regimes in Ibadan-Nigeria. *Journal of Applied Irrigation Science* 42(2): 199–206.

Chen THH & Murata N (2002) Enhancement of tolerance of abiotic stress by metabolic engineering of betaines and other compatible solutes. *Current Opinion in Plant Biology* 5(3): 250–257.

Dowling NG, Greenfield SM & Fisher KS (1998) *Sustainability of Rice in the Global Food System, 1st edition*. International Rice Research Institute, Los Banos, Philippines, 404 p.

Etabo EM, Wekha NW, Korir NK & JPG-Onyango (2018) Effect of Phosphorus Levels on Soil Properties and Plant Tissue of Nerica Varieties. *Asian Soil Research Journal* 1(3): 1–9.

Fujii M, Miyamoti Y & Ishihara S (2006) Studies on drought resistance of *Oryza sativa* L. and NERICA-Comparison of water Use Efficiency estimated by pot experiment. *Journal of Crop Science* 75(Extra Issue 2): 144–145.

Gary WO (2010) *First course in design and analysis of experiments*. University of Minnesota., Minnesota, United States of America.

Insalud N, Bell RW, Colmer TD & Rerkasem B (2006) Morphological and Physiological Responses of Rice (*Oryza sativa*) to Limited Phosphorus Supply in Aerated and Stagnant Solution Culture. *Annals of Botany* 98(5): 995–1004.

Jaetzold R, Schmidt B & Shisanya CA (2006) *Farm Management Handbook of Kenya. Natural Conditions and Farm Information, 2nd 11/C*. Ministry of Agriculture/GTZ., Nairobi, Kenya.

Jaetzold R, Schmidt H, Hornetz B & Shisanya C (2005) *Farm Management Handbook of Kenya Vol. II, Part C*. Ministry of Agriculture, Nairobi, Kenya.

Kanyanjua SM, Ireri L, Wambua S & Nandwa SM (2002) *Acidic soils in Kenya. Constraints and Remedial Options*. KARI Technical Note No. 11, Nairobi, Kenya.

Kimani JM, Tongoona P, Derera J & Nyende AB (2011) Upland rice varieties development through participatory plant breeding. *ARPN Journal of Agricultural and Biological Science* 6(9): 39–49.

Kouko WO, Makihara D, Choke J & Wakhu P (2006) *NERICA research and promotion in Kenya*. JICA seminar on sustainable Rice farming in Africa., Accra, Ghana.

Matsunami M, Matsunami T & Kokubun M (2009) Growth and Yield of New Rice for Africa (NERICAs) under different ecosystems and nitrogen levels. *Plant Production Science* 12(3): 381–389.

Momo JA (2013) Effect of withholding irrigation water after complete heading on rice yield and seed quality in Mwea-Kirinyaga County, (Master's Thesis). Kenyatta University, Nairobi, Kenya.

Nyang'au WO, Mati BM, Kalamwa K, Wanjogu RK & Kiplagat LK (2014) Estimating Rice Yield Under Weather Conditions in Kenya Using CERES Rice Model. *International Journal of Agronomy* 2014: Article ID 849496.

Pal V, Singh MM, Kumar R & Verma SS (2013) Response of irrigation scheduling and Integrated nutrition on scented rice (*Oryza sativa* L.). *Bioinfolet* 10(4C): 1528 –1530.

Payne RW (2009) "Genstat". *Wiley Interdisciplinary Reviews: Computational Statistics* 1(2): 255–258.

Sambroek WG, Braun HMH & Vander Pouw BJA (1982) *Exploratory Soil Map and Agro- climatic of Kenya Report No. E 1*. Kenya Soil Survey, Nairobi, Kenya.

Somado EA, Guei RG & Keya SO (2008) *NERIC: The New Rice for Africa-a compendium*. Africa Rice Center (WARDA), Cotonou, Benin.

Takahashi S, Uesosono S & Nagatomo M (2004) Rice uptake of nitrogen from aerobically and anaerobically composted poultry manure. *Journal of Plant Nutrition* 27(4): 731–741.

Tantawi A & Ghanem SA (2001) Water use efficiency in rice culture. *CIHM-Options Mediterraneenes* 40: 39–45.

Weeda A (1987) *Rating of Land Qualities in Kenya (Third approximation)*. Nairobi, Kenya.