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SUPPLEMENTAL IRRIGATION AND FERTILIZATION TO MITIGATE THE ADVERSE EFFECT OF TERMINAL DROUGHT STRESS ON TRANSPLANTED AMAN RICE

M. A. HASAN[1], R. PARVIN[2], M. H. R. HAFIZ[3]
M. R. ISLAM[4] AND S. SHARMIN[5]

Abstract

An experiment was conducted at Crop Physiology and Ecology Research Field, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during July to December 2021 to assess the impact of terminal drought stress on T. Aman rice and evaluate the efficacy of supplemental irrigation and additional fertilizer application for sustainable production. The study was arranged in split-plot design with three replications. Main plot treatment consisted of three water management options such as I_0- Rain-fed (Control), I_1- One supplemental irrigation (6 cm) at flowering stage, I_2- Two supplemental irrigations (6 cm) at panicle initiation and flowering stage. Sub plot treatment consisted of four nutrient management as, F_1- Recommended doses of inorganic fertilizer (RDF), F_2- 150% of RDF, F_3- 15 t ha^{-1} Farmyard manure + RDF and F_4- 10 t ha^{-1}Biochar + RDF. Rice variety BRRIdhan-94 was used as planting material. Results indicated that T. Aman rice suffered from terminal drought stress affecting growth, physiology and yield attributes. The impact of supplemental irrigation on plant height, tillers hill^{-1}, grains panicle^{-1}, thousand grains weight and grain yield of T. Aman was found significantly positive but there was no significant variation between one and two supplemental irrigations. Additional fertilization, particularly with cattle manure, effectively mitigated the adverse effects of terminal drought stress on T. Aman rice yield. Overall, the study suggests that either one supplemental irrigation or additional fertilization is sufficient to sustain yield under terminal drought stress condition in T. Aman rice cultivation.

Keywords: Irrigation, fertilization, terminal drought stress and T. Aman rice.

Introduction

Aman rice is one of the major crops of Bangladesh contributing approximately 38.8 % of the nation's total rice production (BBS, 2021). The changing climate pattern have disrupted traditional rainfall schedule leading to water stress during critical growth stage of rice cultivation with around 90% of the total rainfall occurring between April to October, the abrupt cessation of monsoon in September can create severe water stress in T. Aman season. After October, rainfall is not sufficient for potential yield of rice and most of the Aman rice remains at the flowering and grain filling stages (Sattar *et al*., 2009). A rice crop can not be sustained during this period

[1,3&4]Professor, Department of Crop Physiology and Ecology, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur-5200, [2]MS Student, Department of Crop Physiology and Ecology, HSTU, Dinajpur-5200, [5]Lecturer, Department of Crop Physiology and Ecology, HSTU, Dinajpur-5200, Bangladesh.

form rainfall alone (Rashid *et al*., 2005). In response to these challenges, the adoption of drought-tolerant rice cultivars and complementary crop management practices becomes important to mitigate risks and enhance productivity and profitability. Haefele *et al*. (2016) reviewed a wide range of studies have highlighted various management options, including water management, cropping systems, improved nutrient management and soil ameliorate strategies, for rain-fed lowland rice cultivation in drought-prone environments. The problem of yield reduction in paddy due to dry spell is overcome by providing supplementary irrigation(s) during this period (Pawar and Dongarwar, 2007). Research indicates that timely supplementary irrigation during the T. Aman season significantly enhance rice yields ranging from 8 to 71 percent over rain-fed condition (Saleh, 1987; BRRI, 1991). Moreover, balanced fertilizer application has been reported to enhance crop resistance to adverse soil conditions, including moisture deficits. (Tisdale *et al*.,1985; Wade *et al*.,1999; Karim and Rahman, 2015). Additionally, the application of biochar has demonstrated positive effects on plant growth, biomass, and yield under drought through increased photosynthesis, nutrient uptake, and modified gas exchange characteristics in moisture stressed plants by improving the physical, chemical and biological properties of soil (Rani *et al*., 2019; Hadiawati *et al*., 2019). Similarly the combined application of poultry litter based compost and inorganic fertilizers increased the rice production and yield through enhanced tiller number, panicle length, 1000-grain weight presumably by increasing nutrient uptake and utilization (Chowdhury *et al*., 2020).

Despite these advancements, limited information exists on the effect of supplemental irrigation, improved nutrient management and soil organic amendments in alleviating the adverse effect of terminal drought stress on Transplanted aman in Bangladesh condition is scanty. Thus, this study aims to investigate the effect of terminal drought on physiology, yield attributes and yield of T. Aman rice, to determine the number of supplemental irrigation during dry spells for sustaining yield of T. Aman rice and also to evaluate the efficacy of additional fertilizer, cattle manure and biochar in alleviating the adverse effect of terminal drought stress on T. Aman rice production.

Materials and Methods

The experiment was conducted at Crop Physiology and Ecology Research Field, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during July 2021 to June 2022. The experimental field was a medium high land belonging to the non-calcareous dark gray floodplain soil under the agro-ecological zone (AEZ-1) of Old Himalayan Piedmont Plain. The soil is sandy loam under the Order Inceptisol. The experimental site is situated in the sub-tropical region characterized by heavy rainfall during the months from May to September and scantly rainfall in the rest of the year. The meteorological data pattern in respect to temperature and rainfall during the growing period of the experimental site are presented in Figure 1 and 2.

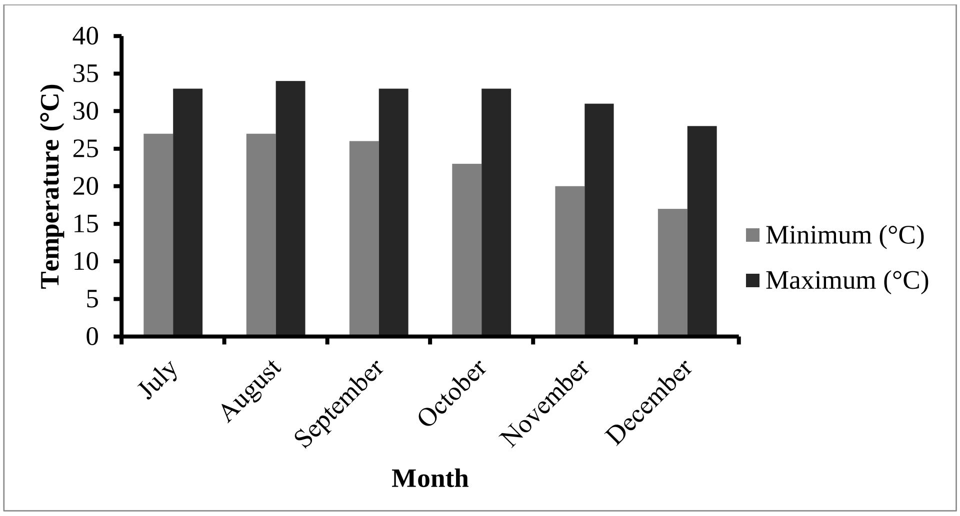

Fig. 1: Temperature (°C) of growing season of T. aman during July to December.

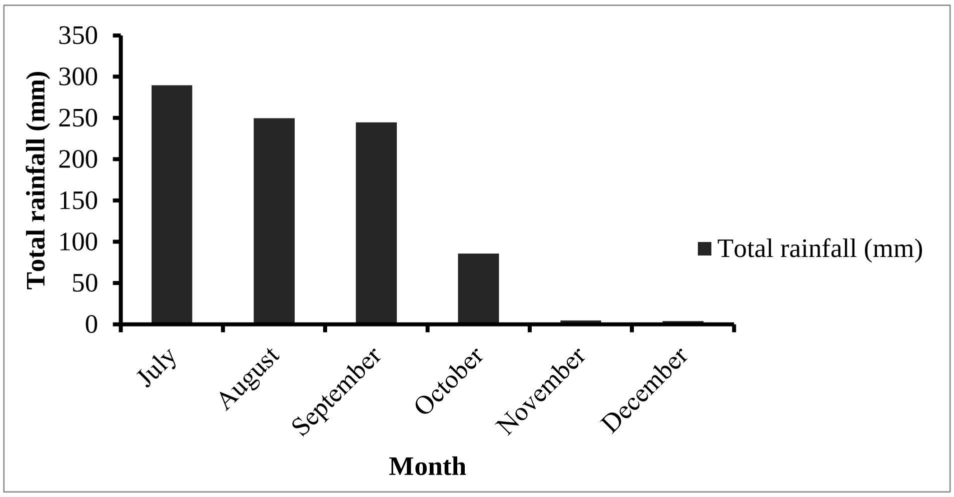

Fig. 2: Total rainfall (mm) of growing season of T. aman during July to December.

The experiment consisted three levels of water management viz. I_0- Rainfed (Control), I_1- One supplemental irrigation (6 cm) at flowering stage and I_2- Two supplemental irrigations (6 cm) at panicle initiation and flowering stage along with four levels of nutrient management viz. F_1- Recommended doses of inorganic fertilizer (RDF), F_2- 150% of RDF, F_3- 15 t ha^{-1} cattle manure + RDF and F_4- 10 t ha^{-1}Biochar + RDF (Dhaliwal *et al.*, 2023; Zohora *et al.*, 2023; Shashi *et al.*, 2018). The experiment was laid out in a split-plot design with three replications assigning water management in the main plots and nutrient management in the sub-plots. Rice variety BRRI dhan-94 was used as planting material.

Seedbed was prepared on 1st July 2021 and seeds were sown uniformly on 5 July 2021.The main land preparation was commenced on last week of July 2021 for cultivation of T. aman rice.

Farmyard manure (15 t/ha), Biochar (10 t/ha), Triple super phosphate (TSP), Muriate of potash (MOP), Gypsum and Zinc Sulfate ($ZnSO_4.7H_2O$) were applied as basal dose during final land preparation as per experimental treatments. Urea was applied in three equal splits. The first dose of urea was applied at l5 days after transplanting of rice seedlings. The rest doses of urea were top dressed at 30 days after transplanting (active tillering stage) and 45 days after transplanting (panicle initiation stage). The recommended doses of fertilizers are N 85, P 14.5, K 70, S 11 and Zn = 1.8kg/ha (BARC, 2005).

Thirty days old seedlings were uprooted carefully and transplanted on the same day on August 6, 2021. The spacing was 20 cm × 20 cm and three healthy seedlings were transplanted in each hill. Rice in control plot was cultivated under rainfed condition. Supplemental irrigated plots were irrigated up to 6 cm on soil surface as par treatments. Weeding, gap filling and other intercultural operations were done as when necessary. Data were recorded on plant parameters such as plant height (cm), number of tillers hill^{-1}, number of panicles hill^{-1}, shoot and root dry weight (g hill^{-1}), panicle length (cm), 1000-grain weight and grain yield (g/m^2). SPAD value was taken from middle portion of five flag leaf at 50, 65 and 80 days after transplanting using SPAD meter (Model: MINOLTA, CHLOROPHYLL METER, SPAD-502, JAPAN). Relative leaf water content was determined at 100 days after transplanting according to Barrs and Weatherly (1962). Water retention capacity was determined at 100 days after transplanting according to Bars and Weatherly (1962). Proline content of the fully expanded flag leaf at 100 days after transplanting from all experimental plots was estimated according to Bates (1973).

Statistical analysis

The data were analyzed by partitioning the total variance with the help of computer using Statistics 10 program. The treatment means were compared using Tukey's test at $p \leq 5\%$ level.

Results and Discussion

Growth parameters

Plant height at different days after transplanting

Plant height recorded at 50, 65 and 80 days after transplanting (DAT) was significantly influenced by the combined effect of supplemental irrigation and fertilization treatments (Table 1). Supplemental irrigation alone or in combination with additional fertilization (50% of RDF, 15 t ha^{-1} cattle manure and 10 t ha^{-1} biochar) favored the height of T. aman rice plant. But the influence was greater at the later growth stages. Chowdhury *et al.* (2020) showed that plant height significantly varies with the applications of poultry compost, biochar and supplemental irrigation. Era *et al.* (2021) also reported similar results.

Table 1. Effect of supplemental irrigation and fertilization on plant height of BRRIdhan- 94 at different days after transplanting in aman season

Supplemental irrigation	Fertilization	Plant height (cm)		
		At 50 DAT	At 65 DAT	At 80 DAT
I_0	F_1	95.6 b	111.0 b	115.0 e
	F_2	100.2 ab	122.2 a	123.7 bcde
	F_3	96.5 b	120.6 a	120.7 cde
	F_4	101.9 ab	121.7 a	130.0 abc
I_1	F_1	95.9 b	119.4 a	122.7 cde
	F_2	102.2 ab	121.6 a	123.3 bcde
	F_3	98.9 ab	120.3 a	133.7 ab
	F_4	99.3 ab	120.2 a	130.2 abc
I_2	F_1	99.1 ab	120.7 a	125.3 abcde
	F_2	101.9 ab	123.6 a	135.0 a
	F_3	103.9 a	123.6 a	130.0 abc
	F_4	99.2 ab	119.2 ab	129.7 abcd
CV (%)		2.23	2.30	2.10
Significance level		*	*	**

In a column, means followed by similar letter(s) did not differ significantly by Tukey's test.

N.B.: DAT indicates days after transplanting, CV indicates co-efficient of variance, * indicates significant at 5% level of probability,** indicates significant at 1% level of probability, I_0- Rainfed (No supplemental irrigation), I_1- One supplemental irrigation (6 cm) at flowering stage,I_2- Two supplemental irrigations (6 cm) at panicle initiation and flowering stage, F_1- Recommended doses of inorganic fertilizer (RDF),F_2- 150% of RDF,F_3- 15 t ha^{-1} Farmyard manure + RDF and F_4- 10 t ha^{-1}Biochar + RDF.

Tillers $hill^{-1}$ at different days after transplanting

Tillers $hill^{-1}$ recorded at 50 and 80 days after transplanting (DAT) was significantly influenced by the combined effect of supplemental irrigation and fertilization treatments except at 65 DAT (Table 2). Supplemental irrigation alone or in combination with additional fertilization (50% of RDF, 15 t ha^{-1} cattle manure and 10 t ha^{-1} biochar) favored the number of tillers $hill^{-1}$ of T. Aman rice. Era *et al.* (2021) reported similar results.

Table 2. Effect of supplemental irrigation and fertilization on tillers $hill^{-1}$ of BRRIdhan- 94 at different days after transplanting in aman season

Supplemental irrigation	Fertilization	Tillers $hill^{-1}$		
		At 50 DAT	At 65DAT	At 80 DAT
I_0	F_1	10.0 j	14.2 a	14.6 g
	F_2	13.6 c-g	18.7 a	17.7 b-f
	F_3	13.3 c-h	20.9 a	18.7 a-d
	F_4	14.0 c-e	20.6 a	18.9 a-c
I_1	F_1	12.9 c-i	18.7 a	17.9 b-f
	F_2	14.8 b-d	21.1 a	18.9 a-c
	F_3	16.9 ab	21.8 a	20.3 ab
	F_4	13.8 c-f	22.3 a	21.7 a
I_2	F_1	13.2 c-i	19.8 a	17.4 b-f
	F_2	15.3 a-c	21.3 a	18.7 a-d
	F_3	17.8 a	22.7 a	18.4 b-f
	F_4	14.4 b-d	22.8 a	18.5 b-e
CV (%)		7.06	5.49	4.02
Significance level		**	NS	**

In a column, means followed by similar letter(s) did not differ significantly by Tukey's test.

Shoot and root dry weight at different days after transplanting

Shoot dry weight $hill^{-1}$ at 50, 65 and 80 days after transplanting (DAT) was significantly influenced by the combined effect of supplemental irrigation and fertilization treatments but root dry weight $hill^{-1}$ was not significantly influenced at 50 and 65 DAT but significant at 80 DAT (Table 3). In that case, supplemental irrigation alone had no effect but additional fertilization alone or in combination with supplemental had remarkable influence on shoot and root dry weight. These results are in agreement with the research findings of Mohanty *et al.* (2018) and Era *et al.* (2021).

Table 3. Effect of supplemental irrigation and fertilization on shoot and root dry weight hill^{-1} of BRRIdhan- 94 at 50, 65 and 80 days after transplanting in aman season

Supplemental irrigation	Fertilization	Dry weight at 50 DAT		Dry weight at 65 DAT		Dry weight at 80 DAT	
		Shoot (g hill^{-1})	Root (g hill^{-1})	Shoot (g hill^{-1})	Root (g hill^{-1})	Shoot (g hill^{-1})	Root (g hill^{-1})
I_0	F_1	19.6 bc	3.4 a	24.8 e	3.57 a	35.0 c	5.02 abc
	F_2	19.9 bc	3.17 a	30.5 d	4.60 a	42.7 ab	5.97 ab
	F_3	20.8 bc	3.10 a	33.1 cd	3.77 a	43.3 a	5.90 ab
	F_4	22.5 abc	3.43 a	33.4 cd	4.03 a	48.0 a	5.10 abc
I_1	F_1	18.9 c	3.13 a	30.7 d	4.20 a	34.3 c	4.47 bc
	F_2	22.6 abc	3.63 a	35.7 bc	4.53 a	48.7 a	5.77 abc
	F_3	20.2 bc	3.37 a	37.7 bc	4.13 a	46.4 a	4.83 abc
	F_4	20.3 bc	2.83 a	39.2 ab	3.70 a	44.0 a	5.07 abc
I_2	F_1	19.5 bc	3.53 a	33.9 cd	4.73 a	35.7 bc	3.27 c
	F_2	20.5 bc	3.07 a	43.3 a	5.50 a	47.0 a	5.73 abc
	F_3	23.3 ab	4.30 a	38.7 ab	4.07 a	48.7 a	5.63 abc
	F_4	25.7 a	4.53 a	39.0 ab	5.70 a	49.0 a	6.97 a
CV (%)		6.24	13.18	4.39	14.89	4.18	13.83
Significance level		**	NS	**	NS	**	*

In a column, means followed by similar letter(s) did not differ significantly by Tukey's test.

Physiological attributes

SPAD value at different days after transplanting

The SPAD value which indicated the greenness of leaf recorded at 65 and 80 days after transplanting (DAT) was significantly influenced by the combined effect of supplemental irrigation and fertilization treatments but it was not significantly influenced at 50 DAT (Table 4). Supplemental irrigation alone or in combination with additional fertilization (50% of RDF, 15 t ha^{-1} cattle manure and 10 t ha^{-1} biochar) improved the SPAD value of leaves. The influence was found greater when one supplemental irrigation was applied than two supplemental irrigation. Mohanty *et al.* (2018) and Era *et al.* (2021) also recorded similar results.

Table 4. Effect of supplemental irrigation and fertilization on SPAD value of leaf of BRRIdhan- 94 at different days after transplanting in aman season

Supplemental irrigation	Fertilization	SPAD value		
		At 50 DAT	At 65DAT	At 80 DAT
I_0	F_1	39.1 a	37.3 b	39.0 b
	F_2	39.9 a	43.7 ab	44.6 a
	F_3	37.0 a	38.6 b	41.2 ab
	F_4	37.6 a	45.6 a	40.4 ab
I_1	F_1	40.4 a	41.8 ab	41.0 ab
	F_2	39.9 a	38.4 b	42.2 ab
	F_3	36.9 a	40.1 ab	42.0 ab
	F_4	39.8 a	39.6 ab	44.9 a
I_2	F_1	39.8 a	39.4 ab	41.3 ab
	F_2	38.8 a	41.4 ab	40.2 ab
	F_3	39.5 a	39.3 ab	40.2 ab
	F_4	40.2 a	39.4 ab	39.2 b
CV (%)		6.78	2.38	4.09
Significance level		NS	**	*

In a column, means followed by similar letter(s) did not differ significantly by Tukey's test.

Water retention capacity

Water retention capacity at 100 days after transplanting (DAT) was significantly influenced by the combined effect of supplemental irrigation and fertilization treatments (Table 5 Supplemental irrigation alone or in combination with additional fertilization (50% of RDF, 15 t ha^{-1} cattle manure and 10 t ha^{-1} biochar) improved the water retention capacity of leaves. The influence was found greater in two supplemental irrigated plots than one supplemental irrigated plots. Rani *et al*. (2019) reported similar results.

Relative leaf water content

The relative leaf water content at 100 days after transplanting (DAT) was significantly increased by the combined effect of supplemental irrigation and fertilization (Table 5). Supplemental irrigations either alone or in combination with additional fertilization treatments (50% of RDF, 15 t ha^{-1} cattle manure and 10 t ha^{-1} biochar) improved the relative leaf water content. This findings aligns with the results reported by Chowdhury *et al*. (2020).

Proline content

The proline content of flag leaf at 100 DAT was significantly affected by the combined effect of supplemental irrigation and fertilization (Table 5). The maximum proline content (1.89 µ mole/ g fresh weight) was recorded when 150% of recommended doses of inorganic fertilizer were applied in rain-fed condition (I_0F_2), but statistically similar to that observed with RDF under rain-fed condition (1.85 µ mole/ g fresh weight). However, supplemental irrigation alone or in combination with additional fertilization (50% of RDF, 15 t ha^{-1} cattle manure and 10 t ha^{-1} biochar) reduced the proline level. These results suggested that T. Aman rice suffered from terminal drought stress which supplemental irrigation, either alone or combined with additional fertilization, helped to alleviate. Karim and Rahman (2015) underscored the importance of balanced fertilization in managing drought risk for increased cereal production. Studies revealed that irrigation alone is not sufficient to obtain satisfactory grain yield without balanced fertilization. Additionally balanced fertilization can improve photosynthetic activity by stabilizing superoxide dismutase (SOD) activity, improve proline, abscisic acid (ABA) levels, thereby enhancing crop drought tolerant and yield.

Table 5. Effect of supplemental irrigation and fertilization on water retention capacity, relative leaf water content and proline content of flag leaf of BRRIdhan- 94 at 100 days after transplanting in aman season

Supplemental irrigation	Fertilization	Water retention capacity (% of initial water content after 24 hours)	Relative leaf water content (%)	Proline content (µ mole/ g fresh weight)
I_0	F_1	5.14 b	82.3 e	1.85 a
	F_2	6.01 ab	84.3 de	1.89 a
	F_3	6.09 ab	91.1 ab	1.70 ab
	F_4	6.34 a	93.1 a	1.35 cd
I_1	F_1	5.89 ab	86.8 cd	1.49 bc
	F_2	6.97 a	93.2 a	1.40 cd
	F_3	6.03 ab	90.8 ab	1.43 c
	F_4	6.36 a	91.3 ab	1.29 cd
I_2	F_1	6.41 a	87.5 bcd	1.38 cd
	F_2	6.49 a	91.8 a	1.20 d
	F_3	6.63 a	92.3 a	1.32 cd
	F_4	6.51 a	90.2 abc	1.34 cd
CV (%)		3.26	1.28	5.45
Significance level		**	**	**

In a column, means followed by similar letter(s) did not differ significantly by Tukey's test

Yield and yield attributes

Grain yield was significantly increased but the straw yield was not significantly influenced by the combined use of supplemental irrigation and fertilizer application (Table 6). The lowest grain yield (583 g m^{-2}) was recorded when recommended doses of inorganic fertilizer (RDF) were applied in rain-fed condition (I_0F_1) which was followed by one supplemental irrigation with RDF (662 g m^{-2}), two supplemental irrigation with RDF (680 g m^{-2}) and two supplemental irrigation with 15 t ha^{-1} farmyard manure + RDF (688 g m^{-2}). The maximum grain yield was obtained from one supplemental irrigation with 10 t ha^{-1} biochar + RDF (756 g m^{-2}) followed by one supplemental irrigation with 150% of RDF (740 g m^{-2}), one supplemental irrigation with 15 t ha^{-1} farmyard manure + RDF (746 g m^{-2}) and rain-fed condition with 10 t ha^{-1} biochar + RDF (722 g m^{-2}). Other treatments provided moderate yield. The result indicated that supplemental irrigation and additional fertilization (50% of RDF, 15 t ha^{-1} cattle manure and 10 t ha^{-1} biochar) alone or combination of both significantly increased the grain yield (662 to 756 g m^{-2}). The increase in grain yield was contributed by increase in number of panicles $hill^{-1}$, grains $panicle^{-1}$ and thousand grain weight in the respective treatment combinations (Table 7). The performance of grain yield indicates that one supplemental irrigation performed better than two supplemental irrigations. One supplemental irrigation or additional fertilization was found suitable in alleviating the adverse effect of terminal drought stress. Similar results were obtained by Rahman *et al*. (2002), Shamsuzzaman (2007), Kabir (2011) and Mohanty *et al.* (2018).

Soil nutrient status

Organic carbon (%), organic matter (%) and total N (%) were significantly influenced by the combined effect of supplemental irrigation and fertilizer application treatments, but available P, exchangeable K and available S content were not significantly influenced by the combined effect of supplemental irrigation and fertilization treatments (Table 7). Significantly the highest organic carbon (0.613%), organic matter (1.053%) and total N (0.053%) were recorded when cattle manure @ 15 t ha^{-1} was applied in rain-fed condition (I_0F_3). Similar results are reported by Wade *et al*. (1999) and Rouf *et al.* (2018).

Conclusion

Results of the present study indicated that one supplemental irrigation or additional fertilization (150% of RDF, 15 t ha^{-1} farmyard manure + RDF and 10 t ha^{-1} biochar + RDF) can alleviate the adverse effect of terminal drought stress effectively.

Table 6. Effect of supplemental irrigation and fertilization on growth and yield of BRRIdhan- 94 at harvest in aman season

Supplemental irrigation	Fertilization	Tillers hill^{-1}	Panicles hill^{-1}	Plant height (cm)	Panicles length (cm)	Grains panicle^{-1}	Thousand grain weight (g)	Grain yield hill^{-1} (g)	Grain yield m^{-2} (g)	Straw yield m^{-2} (g)
I_0	F_1	13.9 c	12.2 c	117.7 d	25.3 a	187.4 e	18.6 b	42.9 c	583 f	920 a
	F_2	15.9bc	14.2ab	126.4 c	27.8 a	233.3 abcd	20.26 ab	54.1ab	710 abcde	1050 a
	F_3	17.5ab	15.1ab	127.3bc	26.9 a	210.3 bcde	20.1ab	52.7 b	686 cde	1170 a
	F_4	18.1 a	15.6ab	131.8abc	26.4 a	227.7 abcd	20.6 a	55.5ab	722 abcd	1100 a
I_1	F_1	16.3abc	14.6ab	124.7 cd	26.4 a	202.9 de	20.3 a	52.1 b	662 e	1090 a
	F_2	16.6ab	14.9ab	131.9ab	26.5 a	212.9 bcde	20.9 a	54.7ab	740 abc	1220 a
	F_3	17.4ab	15.1ab	135.1ab	27.3 a	230.9 abcd	21.28 a	59.7 a	746 ab	1130 a
	F_4	17.6ab	15.3ab	131.6abc	26.3 a	205.1 cde	21.0 a	58.1ab	756 a	1087 a
I_2	F_1	16.3abc	13.9 b	129.8bc	26.9 a	233.7 abcd	20.6 a	55.1ab	680 de	1100 a
	F_2	17.9ab	14.7ab	138.9 a	27.7 a	242.0 ab	20.0ab	56.4ab	703 abcde	1180 a
	F_3	16.2abc	15.7 a	132.4ab	28.7 a	235.0 acb	20.2ab	58.9ab	688 cde	1100 a
	F_4	17.8ab	15.3ab	135.7ab	28.9 a	249.0 a	20.7 a	58.2ab	698 bcde	1240 a
CV (%)		4.28	3.90	1.40	3.19	3.97	2.75	3.63	2.75	8.35
Significance level		**	*	**	NS	**	*	**	*	NS

In a column, means followed by similar letter(s) did not differ significantly by Tukey's test.

N.B.: DAT indicates days after transplanting, CV indicates co-efficient of variance, NS indicates not significant, * indicates significant at 5% level of probability, ** indicates significant at 1% level of probability, I_0- Rainfed (No supplemental irrigation), I_1- One supplemental irrigation (6 cm) at flowering stage,I_2- Two supplemental irrigations (6 cm) at panicle initiation and flowering stage, F_1- Recommended doses of inorganic fertilizer (RDF),F_2- 150% of RDF,F_3- 15 t ha^{-1} Farmyard manure + RDF and F_4- 10 t ha^{-1}Biochar + RDF.

Table 7. Nutrient status of soil as influenced by supplemental irrigation and fertilization on BRRIdhan- 94 rice field in aman season

Supplemental Irrigation	Fertilization	Organic carbon (%)	Organic matter (%)	Total Nitrogen (%)	Available P (ppm)	Exchangeable K (meq/100g soil)	Available S (ppm)
I_0	F_1	0.400 b	0.690 bc	0.039 bc	14.70 a	0.167 a	5.04 a
	F_2	0.400 b	0.690 bc	0.040 b	15.51 a	0.167 a	5.51 a
	F_3	0.613 a	1.053 a	0.053 a	15.99 a	0.180 a	5.94 a
	F_4	0.280 b	0.480 cd	0.024 de	15.45 a	0.190 a	7.84 a
I_1	F_1	0.280 b	0.480 cd	0.024 de	13.34 a	0.227 a	6.09 a
	F_2	0.307 b	0.527 bcd	0.027 cde	12.94 a	0.203 a	6.87 a
	F_3	0.427 b	0.733 b	0.036 bcd	13.90 a	0.230 a	3.93 a
	F_4	0.333 b	0.573 bcd	0.029 bcde	14.31 a	0.250 a	5.19 a
I_2	F_1	0.267 b	0.457 d	0.023 e	13.02 a	0.180 a	6.81 a
	F_2	0.293 b	0.503 bcd	0.027 cde	12.94 a	0.203 a	6.20 a
	F_3	0.427 b	0.733 b	0.037 bcd	13.90 a	0.230 a	3.93 a
	F_4	0.320 b	0.550 bcd	0.028 bcde	13.42 a	0.240 a	5.19 a
CV (%)		16.70	12.87	12.66	13.09	15.45	28.34
Significance level		*	*	**	NS	NS	NS

In a column, means followed by similar letter(s) did not differ significantly by Tukey's test.

N.B.: DAT indicates days after transplanting, CV indicates co-efficient of variance, NS indicates not significant, * indicates significant at 5% level of probability, ** indicates significant at 1% level of probability, I_0- Rainfed (No supplemental irrigation), I_1- One supplemental irrigation (6 cm) at flowering stage, I_2- Two supplemental irrigations (6 cm) at panicle initiation and flowering stage, F_1- Recommended doses of inorganic fertilizer (RDF), F_2- 150% of RDF, F_3- 15 t ha^{-1} Farmyard manure + RDF and F_4- 10 t ha^{-1}Biochar + RDF.

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