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Influence of Irrigation Scheduling and Nutrient Application on Water Use, Productivity and Profitability of Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

Background: Irrigation and proper nutrient management that determines the productivity of the groundnut especially during the critical stages of the crop growth.

Methods: The experiments laid out in split plot design comprising of three levels of irrigation scheduling [0.8 IW/CPE ratio (I_1), 0.6 IW/CPE ratio (I_2) and 0.4 IW/CPE ratio (I_3)] in main plots and four nutrient management practices *viz.,* N_1- 75% of RDF with 5 t of charred rice husk, N_2 - 50% of RDF with 5 t of charred rice husk, N_3 - 75% of RDF with 5 t of charred rice husk along with seed treatment of *Abuscular mycorrhiza* and N_4 - 50% of RDF with 5 t of charred rice husk along with seed treatment *Arbuscular mycorrhiza* in sub plots and replicated thrice.

Result: Highest pod yield (2003, 2099 and 2063 kg ha^{-1} during summer, *kharif* and *rabi* 2017, respectively) of groundnut was registered with irrigation scheduling at 0.8 IW/CPE ratio along with 75% of RDF and 5 t of charred rice husk as basal with seed treatment of *Arbuscular mycorrhiza*. The maximum water use efficiency was also recorded under of the same treatment (4.16, 7.07 and 4.86 kg ha^{-1} mm^{-1} during the various seasons respectively). The highest B:C ratio of 2.2, 2.4 and 2.2 was recorded during summer, *kharif* and *rabi* 2017, respectively were also registered with same combination irrigation and nutrient management.

Key words: Groundnut, Irrigation scheduling, Nutrient management, Water use efficiency, Yield.

INTRODUCTION

India is one of the largest producers of oilseeds in the world and plays an important role in groundnut (*Arachis hypogaea* L.) is an important oilseed crop in India which occupies first position in terms of area and second position in terms of production with a cultivated area of 5.34 million hectares and production of 7.46 million tons with an average productivity of 1398 kg ha^{-1} during 2016-17. Tamil Nadu ranks third in the country both in area (2.82 lakh hectares) and production (5.91 lakh tons) with an average productivity of 2084 kg ha^{-1} during 2016-17. Timely availability of assured irrigation and nutrient management are the important factors that determine the productivity of the groundnut especially during the critical stages (flowering and peg formation stage). Continuous application of inorganic fertilizers is uneconomical considering the increase in prices of chemical fertilizer. Rice husk is the natural sheath and it is about 20 per cent by the weight of the rice harvested and in it 80 per cent by weight of the raw husk is made of organic components. Annual rice husk available in India is approximately 24 million tons (Shwetha *et al*., 2014). Incorporation of rice husk into soil was found to exhibit beneficial effect on a variety of crops (Sharma *et al*., 1984). Charred rice husk is a unique adsorbent material with diffusion and catalytic properties characterized by 20 to 30 per cent pore space. *Arbuscular mycorrhiza* is known to form mutualistic relationships with more than 80 per cent of crop plants. Beneficial effects on application of NPK with soil amendment of charred rice husk along with seed treatment of *Arbuscular mycorrhiza* is an opportunity to increase the crop productivity due to their combined and synergistic effects that help to concurrently improve physical, chemical and biological properties of soil. Present investigation was carried out to study the influence of irrigation scheduling

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and nutrient management practices with soil amendment of charred rice husk and seed treatment of *Arbuscular mycorrhiza* on productivity and water use efficiency of groundnut.

MATERIALS AND METHODS

Field experiments were conducted at AC&RI, Tamil Nadu Agricultural University, Madurai to find out the efficient irrigation scheduling and nutrient management practices with charred rice husk and seed treatment with *Arbuscular mycorrhiza* in groundnut. The time of sowing was 16.02.2017, 06.08.2017 and 21.12.2017 during summer, *kharif* and *rabi* 2017 and the date of harvesting was 02.06.2017, 20.11.2017 and 18.04.2018 during summer, *kharif* and *rabi*, respectively. The total quantity of water applied during summer (400, 250 and 250 mm), *kharif* (200, 150 and 100 mm) and *rabi* (450, 350 and 250 mm) for IW/CPE ratio 0.8, 0.6 and 0.4, respectively. A total rainfall of 132.2, 372.8 and 16.6 mm were received during summer, *kharif* and *rabi* 2017, respectively. The soil of the experimental field was sandy loam in texture and belongs to vylogam series. The soil was low in available nitrogen (151.50, 158.75 and 156.00 kg ha^{-1}), medium in available phosphorus (21.20, 24.00 and 23.00 kg ha^{-1}) and high in available potassium (191.50, 199.50 and 197.00 kg ha^{-1}). The experiment was laid out in a split plot design with three replications. The main plots consisted of three levels of irrigation scheduling *viz.,* I_1- 0.8 IW/CPE ratio, I_2- 0.6 IW/CPE ratio and I_3- 0.6 IW/CPE ratio and sub plot comprised of four level of nutrient management namely N_1 - 75% of RDF + 5 t ha^{-1} of charred rice husk, N_2 - 50% of RDF + 5 t ha^{-1} of charred rice husk, N_3 - 75% of RDF + 5 t ha^{-1} of charred rice husk with seed treatment of *Arbuscular mycorrhiza* and N_4 - 50% of RDF + 5 t ha^{-1} of charred rice husk with seed treatment of *Arbuscular mycorrhiza*. Groundnut cultivar 'VRI-2', a bunch variety having duration of 100-110 days was used. The seeds were treated with *Arbuscular mycorrhiza* culture at 10 g ha^{-1} of seeds. A seed rate of 125 kg kernel ha^{-1} was used. Spacing of 30 cm between rows and 10 cm between plants was adopted. A plot with recommended dose of fertilizer along with irrigation scheduling at 1.0 IW/CPE ratio was maintained outside the experimental plot for comparison. Triple channel lay out was adopted for main plot treatments so as to eliminate the effect of lateral seepage. For every irrigation, 50 mm of water was applied to each plot using Parshall flume in closed channels. Daily readings of evaporation were recorded from USWB class "B" open pan evaporimeter and irrigations were scheduled based on IW/CPE ratio, as cumulated over days since previous irrigation by subtracting effective rainfall received during that period. Soil amendment *i.e.,* charred rice husk was applied at 5 t ha^{-1} (moisture free) incorporated well in the field before sowing of crops. The entire quantity of nutrients (N, P and K) *i.e.,* 25:50:75 kg ha^{-1} was applied as basal before sowing of seeds. Growth parameters like plant height, leaf area index and dry matter production and yield attributes *viz.,* number of pods $plant^{-1}$, grain yield and haulm yield were recorded and the experimental data collected were subjected for statistical analysis for split plot design as suggested by (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effect of irrigation scheduling and nutrient management practices on growth attributes

Plant height and dry matter production was influenced by irrigation scheduling and nutrient management practices (Table 1 and 2). The significantly taller plants of 47.70, 47.03 and 48.66 cm and dry matter production of 5079, 4851 and 5103 kg ha^{-1} at harvest during *kharif, rabi* and summer, respectively were observed with irrigation scheduling at 0.8 IW/CPE ratio and it was comparable with irrigation scheduling at 0.6 IW/CPE ratio. The increased soil moisture availability to the crop might have provided optimum moisture supply and uptake by the crop resulting in increase in cell division, stem elongation and finally increased plant height and dry matter production. Earlier works of Hallikeri *et al.* (2009); Ahlawat and Gangaiah, (2010) corroborates with the above findings. The shorter plants were observed with irrigation scheduling at 0.4 IW/CPE ratio. The decreased soil moisture availability owing to decreased water supply at irrigation scheduling at 0.4 IW/CPE resulted in stunted growth, probably due to decreased absorption of water, leading to poor growth. The results of reduced moisture supply resulting in reduced plant height and dry matter production has been reported by Hassan *et al.* (2016).

Among the nutrient management practices, the higher plant height and dry matter production was observed with application of 75% of RDF adding with 5 tons of charred rice husk along with seed treatment of *Arbuscular mycorrhiza* with a plant height of 49.26, 46.32 and 48.25 cm and dry matter production of 5030, 4805 and 4998 kg ha^{-1} during *kharif, rabi* and summer, respectively. Application of charred rice husk along with adequate moisture might have increased the microbial activity due to presence of adequate carbon in the soil and provide good microclimatic environment in the rhizosphere. Further, conjugation of *Arbuscular mycorrhiza* could have paved way for increased availability of nutrients resulting in enhanced root growth. It also creates more adsorptive surface for uptake of nutrients by the crop. Hogan, (2011); Zhang *et al.* (2014) reported that increased growth parameters due to application of charred rice husk along with inorganic fertilizers. The lower plant height and dry matter production was recorded with application of 50% of RDF along with 5 t charred rice husk during all the seasons.

Effect of irrigation scheduling and nutrient management practices on yield

Irrigation scheduling at 0.8 IW/CPE ratio recorded the higher pod yield and haulm yield of 2005 and 4841 kg ha^{-1} during *kharif*, 1890 and 4810 kg ha^{-1} during *rabi* and 1869 and 4828 kg ha^{-1} during summer 2017, respectively (Table 3 and 4). This was comparable with irrigation scheduling at 0.6 IW/CPE ratio. This might be due to charred rice husk could act

Table 1: Effect of irrigation scheduling and nutrient management practices on plant height (cm) of groundnut at harvest during *kharif, rabi* and summer 2017.

Treatment	*Kharif*				*Rabi*				Summer			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
N_1	48.58	47.60	40.53	45.57	44.74	43.70	37.83	42.12	47.89	46.56	42.46	45.60
N_2	41.52	40.28	39.80	40.53	44.65	41.81	36.42	40.91	47.70	45.22	42.13	45.07
N_3	52.79	51.43	43.57	49.26	51.21	46.05	42.61	46.32	50.06	49.46	45.22	48.25
N_4	47.90	48.15	42.50	46.18	47.62	47.86	39.43	44.80	48.91	47.89	45.78	47.53
Mean	47.70	46.86	41.60		47.03	44.83	38.62		48.66	47.28	43.90	
	I	**N**	**I × N**	**N × I**	**I**	**N**	**I × N**	**N × I**	**I**	**N**	**I × N**	**N × I**
CD (p=0.05)	1.84	1.50	1.93	1.93	1.90	1.54	1.99	1.99	3.02	2.48	3.20	3.20

Main plot: Irrigation scheduling
I_1 : 0.8 IW/CPE
I_2 : 0.6 IW/CPE
I_3 : 0.4 IW/CPE

Sub plot: Nutrient management practices.
N_1: 75% RDF + 5 t ha^{-1} of charred rice husk.
N_2: 50% RDF + 5 t ha^{-1} of charred rice husk.
N_3: 75% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.
N_4: 50% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.

Table 2: Effect of irrigation scheduling and nutrient management practices on dry matter production (kg ha^{-1}) of groundnut at harvest during *kharif, rabi* and summer 2017.

Treatment	*Kharif*				*Rabi*				Summer			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
N_1	4962	4663	4250	4625	4750	4554	4119	4474	4966	4654	3984	4534
N_2	4904	4530	4153	4529	4588	4389	4005	4327	4978	4735	3926	4546
N_3	5328	5275	4486	5030	5076	4981	4359	4805	5323	5276	4397	4998
N_4	5120	5068	4428	4872	4992	4728	4295	4672	5145	5036	4371	4850
Mean	5079	4884	4329		4851	4663	4194		5103	4925	4169	
	I	**N**	**I × N**	**N × I**	**I**	**N**	**I × N**	**N × I**	**I**	**N**	**I × N**	**N × I**
CD (p=0.05)	250	201	259	259	208	184	237	237	110	119	153	153

Main plot: Irrigation scheduling
I_1 : 0.8 IW/CPE
I_2 : 0.6 IW/CPE
I_3 : 0.4 IW/CPE

Sub plot: Nutrient management practices
N_1: 75% RDF + 5 t ha^{-1} of charred rice husk.
N_2: 50% RDF + 5 t ha^{-1} of charred rice husk.
N_3: 75% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.
N_4: 50% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.

Table 3: Effect of irrigation scheduling and nutrient management practices on pod yield (kg ha^{-1}) of groundnut during *kharif, rabi* and summer 2017.

Treatment	*Kharif*				*Rabi*				Summer			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
N_1	1978	1845	1329	1717	1810	1662	1251	1574	1830	1693	1275	1599
N_2	1871	1766	1288	1641	1749	1644	1266	1553	1726	1646	1236	1536
N_3	2099	2022	1685	1935	2063	2001	1498	1854	2003	1978	1365	1783
N_4	2075	2004	1623	1901	1937	1857	1415	1736	1918	1886	1433	1745
Mean	2005	1909	1481		1890	1791	1357		1869	1800	1328	
	I	**N**	**I × N**	**N × I**	**I**	**N**	**I × N**	**N × I**	**I**	**N**	**I × N**	**N × I**
CD (p=0.05)	75	95	122	122	94	99	128	128	117	108	140	140
RDF	1598				1478	1470						

Main plot: Irrigation scheduling
I_1: 0.8 IW/CPE
I_2: 0.6 IW/CPE
I_3: 0.4 IW/CPE

Sub plot: Nutrient management practices
N_1: 75% RDF + 5 t ha^{-1} of charred rice husk.
N_2: 50% RDF + 5 t ha^{-1} of charred rice husk.
N_3: 75% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.
N_4: 50% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.

Table 4: Effect of irrigation scheduling and nutrient management practices on haulm yield (kg ha^{-1}) of groundnut during *kharif, rabi* and summer 2017.

Treatment	*Kharif*				*Rabi*				Summer			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
N_1	4760	4471	3897	4376	4658	4208	4132	4333	4726	4616	4155	4499
N_2	4606	4384	3768	4253	4548	4489	4016	4351	4715	4538	4023	4425
N_3	5062	5004	4272	4779	5083	4950	4338	4790	4984	4846	4401	4743
N_4	4936	4863	4215	4671	4950	4770	4128	4616	4888	4809	4330	4675
Mean	4841	4681	4038		4810	4604	4153		4828	4702	4227	
	I	**N**	**I × N**	**N × I**	**I**	**N**	**I × N**	**N × I**	**I**	**N**	**I × N**	**N × I**
CD (p=0.05)	170	172	222	222	2386	186	239	239	180	124	160	160
RDF	4205				4214				4380			

Main plot: Irrigation scheduling
I_1 : 0.8 IW/CPE
I_2 : 0.6 IW/CPE
I_3 : 0.4 IW/CPE

Sub plot: Nutrient management practices
N_1: 75% RDF + 5 t ha^{-1} of charred rice husk.
N_2: 50% RDF + 5 t ha^{-1} of charred rice husk.
N_3: 75% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.
N_4: 50% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.

as a medium for adsorption and desorption of plant nutrients, besides providing favourable conditions for soil microorganisms. This might have resulted in higher carbon, phosphorus and potassium availability to plants with greater stabilization of organic matter, concurrent with slower nutrient release from the added organic matter. The better retention of cations due to greater cations exchange capacity could have also resulted in immediate beneficial effects of soil nutrient availability resulting in higher value of crop growth parameters *viz.* plant height, leaf area index, dry matter production which ultimately reflected in yield attributes *viz.,* number of flowers, total number of pods per plant and pod yield. The present findings are in consonance with the findings of Zhang *et al.* (2014); Kannan *et al.* (2016). The lower pod yield (1481, 1357 and 1328 kg ha^{-1} during *kharif, rabi* and summer, respectively) and haulm yield (4038, 4153 and 4227 during *kharif, rabi* and summer, respectively) was observed with irrigation scheduling at 0.4 IW/CPE ratio during all the seasons.

With respect to nutrient management practices, application of 75% of RDF in combination with 5 t of charred rice husk along with seed treatment of *Arbuscular mycorrhiza* recorded the higher pod yield (1935, 1854 and 1783 kg ha^{-1} during *kharif, rabi* and summer, respectively) and haulm yield (4779, 4790 and 4743 kg ha^{-1} during *kharif, rabi* and summer, respectively). This was followed by application of 50% of RDF with 5 t of charred rice husk along with seed treatment of *Arbuscular mycorrhiza*. The presence growth promoting substances due to colonization of *Arbuscular mycorrhiza* promoted plant growth and could have increased the chlorophyll production by boosting the photosynthetic process and stimulating vegetative growth. Thus, an overall plant performance would have enhanced accordingly and finally reflecting through increased production of haulm (Gouda *et al.,* 2018).

Interaction between irrigation scheduling and nutrient management practices also significantly influenced the pod yield. Among the irrigation scheduling and nutrient management practices, the pod yield was highest with the combination of irrigation scheduling at 0.8 IW/CPE ratio along with 75% of RDF and 5 t of charred rice husk along with seed treatment of *Arbuscular mycorrhiza* with a pod yield of 2003, 2099 and 2063 kg ha^{-1} during summer, *kharif* and *rabi* 2017 respectively. Whereas, the lowest pod yield was recorded with irrigation scheduling at 0.4 IW/CPE ratio along with 75% of RDF and 5 t of charred rice husk

Effect of irrigation scheduling and nutrient management practices on water use efficiency

The maximum water use efficiency was recorded under irrigation scheduling at 0.8 IW/CPE ratio with a value of 4.16, 7.07 and 4.86 kg ha^{-1}mm^{-1} during summer, *kharif* and *rabi* 2017, respectively (Table 5, 6 and 7). The higher water use efficiency at irrigation scheduling at 0.8 IW/CPE ratio might have largely resulted from constant soil moisture content at or near field capacity level and adding of charred rice husk improved physical soil properties, such as increased soil aggregations, water holding capacity, decreased soil strength and percentage water holding capacity, that enhanced by the carbonization process, resulting in increase in water retention. These findings are in conformity with those of (Srivastava and Chauvan 1995) in groundnut. The nutrient management practices had also exerted its influence on water use efficiency in all the experimental seasons. Application of 75% of RDF with 5 t of charred rice husk along with seed treatment of *Arbuscular mycorrhiza* recorded the maximum water use efficiency of 3.94, 6.83 and 4.74 kg ha^{-1}mm^{-1} during summer, *kharif* and *rabi* 2017, respectively. The minimum water use efficiency was recorded in 50% of RDF with 5 t of charred rice husk.

Effect of irrigation scheduling and nutrient management practices on water productivity

Imparting different irrigation scheduling noticeably influenced the water productivity of groundnut crop in all the three

seasons and the data are furnished in Table 5, 6 and 7. The lower water productivity (` 214.03 and 227.83 $m^{-3}$ during summer and r*abi* 2017, respectively) was recorded with irrigation scheduling at 0.8 IW/CPE ratio. However, during *kharif* 2017, irrigation scheduling at 0.8 IW/CPE ratio recorded higher waters use efficiency of ` 257.35 m^{-3}. Among the nutrient management practices, application of 75% of RDF along with 5 t of charred rice husk and seed treatment with *Arbuscular mycorrhiza* recorded the higher water productivity during all the three seasons.

Table 5: Effect of irrigation scheduling and nutrient management practices on water use efficiency and water productivity of groundnut during summer 2017.

Treatment	Water use efficiency (kg $ha^{-1}mm^{-1}$)				Water productivity (` m^{-3})			
	I_1	I_2	I_3	Mean	I	I,	If	Mean
N_1	6.95	6.48	4.67	6.06	248.16	214.73	201.45	221.45
N_2	6.57	6.20	4.52	5.83	247.12	223.88	188.58	219.86
N_3	7.37	7.10	5.92	6.83	274.75	256.71	227.07	252.84
N_4	7.29	7.04	5.70	6.74	259.26	247.34	219.69	242.10
Mean	7.07	6.73	5.23		257.32	235.67	209.20	

Data not statistically analyzed.

Main plot: Irrigation scheduling
I_1 : 0.8 IW/CPE
I_2 : 0.6 IW/CPE
I_3 : 0.4 IW/CPE

Sub plot: Nutrient management practices
N_1 : 75% RDF + 5 t ha^{-1} of charred rice husk.
N_2 : 50% RDF + 5 t ha^{-1} of charred rice husk.
N_3 : 75% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.
N_4 : 50% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.

Table 6: Effect of irrigation scheduling and nutrient management practices on water use efficiency and water productivity of groundnut during *rabi* 2017.

Treatment	Water use efficiency (kg $ha^{-1}mm^{-1}$)				Water productivity (` m^{-3})			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
N_1	4.63	4.25	3.24	4.04	219.62	254.66	274.16	249.70
N_2	4.47	4.20	3.20	4.02	217.29	266.54	270.88	251.35
N_3	5.27	5.11	3.83	4.74	242.40	302.63	312.54	285.85
N_4	4.95	4.75	3.62	4.44	231.70	277.92	313.60	274.41
Mean	4.86	4.63	3.52		227.83	275.44	292.59	

Data not statistically analyzed.

Main plot: Irrigation scheduling
I_1 : 0.8 IW/CPE
I_2 : 0.6 IW/CPE
I_3 : 0.4 IW/CPE

Sub plot: Nutrient management practices
N_1 : 75% RDF + 5 t ha^{-1} of charred rice husk.
N_2 : 50% RDF + 5 t ha^{-1} of charred rice husk.
N_3 : 75% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.
N_4 : 50% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.

Table 7: Effect of irrigation scheduling and nutrient management practices on water use efficiency and water productivity of groundnut during *kharif* 2017.

Treatment	Water use efficiency (kg $ha^{-1}mm^{-1}$)				Water productivity (` m^{-3})			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
N_1	3.97	3.68	2.77	3.57	251.43	240.48	207.60	221.17
N_2	3.75	3.57	2.68	3.36	202.26	246.28	204.31	217.62
N_3	4.35	4.30	2.96	3.94	235.07	285.40	222.59	247.69
N_4	4.17	4.10	3.11	3.83	205.32	272.21	232.32	236.62
Mean	4.16	3.94	2.96		214.03	261.09	216.62	

Data not statistically analyzed.

Main plot: Irrigation scheduling
I_1 : 0.8 IW/CPE
I_2 : 0.6 IW/CPE
I_3 : 0.4 IW/CPE

Sub plot: Nutrient management practices
N_1 : 75% RDF + 5 t ha^{-1} of charred rice husk.
N_2 : 50% RDF + 5 t ha^{-1} of charred rice husk.
N_3 : 75% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.
N_4 : 50% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.

Effect of irrigation scheduling and nutrient management practices on economics

With an increase in irrigation frequency, the total expense on cultivation increases consequently (Table 8, 9 and 10). The irrigation scheduling at 0.4 IW/CPE ratio along with application of 50% of RDF incurred the lowest cost of cultivation of ` 49500 $ha^{-1}$, ` 48100 ha^{-1} and ` 49500 ha^{-1} during summer, *kharif* and *rabi* 2017, respectively. While, the highest cost of cultivation was recorded with treatment of irrigation scheduling at 0.8 IW/CPE ratio and application of 75% of RDF with 5 t charred rice husk along with seed treatment of *Arbuscular mycorrhiza* during all the three field experiments. The highest Gross return (` 116127, 126605 and 117756 $ha^{-1}$ during summer, *kharif* and *rabi* 2017, respectively), net return (` 62127, 74605 and 63756 ha^{-1} during summer, *kharif* and *rabi* 2017, respectively) and B:C ratio of 2.2, 2.4 and 2.2 during summer, *kharif* and *rabi* 2017 respectively were registered with irrigation scheduling at 0.8 IW/CPE ratio and application of 75% of RDF with 5 t of charred rice husk along with seed treatment of *Arbuscular mycorrhiza*. This could be ascribed to higher expenses incurred to organic amendment and lower marginal returns with these sources. Improvement in soil health due to continuous application of soil amendment, if converted into

Table 8: Effect of irrigation scheduling and nutrient management practices on economics of groundnut cultivation during *kharif* 2017.

Treatment	Cost of cultivation (` ha^{-1})	Gross return (` ha^{-1})	Net return (` ha^{-1})	B:C ratio
I_1N_3	52000	126605	74605	2.4
I_1N_2	48200	113875	65775	2.2
I_1N_4	48300	119469	70169	2.4
I_1N_1	51800	114350	62550	2.2
I_2N_3	52000	122474	70474	2.4
I_2N_4	48300	118008	69708	2.3
I_2N_2	48150	106815	58715	2.1
I_2N_1	51800	102450	50650	2.0
I_3N_3	52000	97775	45775	1.9
I_3N_4	48300	94599	46299	1.8
I_3N_1	51800	86745	38645	1.8
I_3N_2	48100	81204	29404	1.6

Data not statistically analyzed.

Main plot: Irrigation scheduling.
I_1 : 0.8 IW/CPE
I_2 : 0.6 IW/CPE
I_3 : 0.4 IW/CPE

Sub plot: Nutrient management practices.
N_1 : 75% RDF + 5 t ha^{-1} of charred rice husk.
N_2 : 50% RDF + 5 t ha^{-1} of charred rice husk.
N_3 : 75% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.
N_4 : 50% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.

Table 9: Effect of irrigation scheduling and nutrient management practices on economics of groundnut cultivation during *rabi* 2017.

Treatment	Cost of cultivation (` ha^{-1})	Gross return (` ha^{-1})	Net return (` ha^{-1})	B:C ratio
I_1N_3	54000	117756	63756	2.2
I_1N_2	50100	106693	56593	2.0
I_1N_4	50300	112561	62261	2.2
I_1N_1	53800	105560	51760	2.0
I_2N_3	53750	116087	62337	2.2
I_2N_4	50050	106610	56560	2.1
I_2N_2	49850	102244	52394	2.0
I_2N_1	53550	97688	44138	1.8
I_3N_3	53400	89323	35923	1.7
I_3N_4	49700	89626	39926	1.7
I_3N_1	53200	78354	25154	1.5
I_3N_2	49500	77417	25054	1.4

Data not statistically analyzed

Main plot: Irrigation scheduling
I_1 : 0.8 IW/CPE
I_2 : 0.6 IW/CPE
I_3 : 0.4 IW/CPE

Sub plot: Nutrient management practices
N_1 : 75% RDF + 5 t ha^{-1} of charred rice husk.
N_2 : 50% RDF + 5 t ha^{-1} of charred rice husk.
N_3 : 75% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.
N_4 : 50% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.

Table 10: Effect of irrigation scheduling and nutrient management practices on economics of groundnut cultivation during summer 2017.

Treatment	Cost of cultivation (` ha^{-1})	Gross return (` ha^{-1})	Net return (` ha^{-1})	B:C ratio
I_1N_3	54000	116127	62127	2.2
I_1N_2	50100	100930	50830	2.0
I_1N_4	50300	101430	60130	2.1
I_1N_1	53800	106420	52620	2.0
I_2N_3	53750	114730	60980	2.2
I_2N_4	50050	109430	59380	2.1
I_2N_2	49850	99005	49155	2.0
I_2N_1	53550	96674	43124	1.8
I_3N_3	53400	81290	27890	1.5
I_3N_4	49700	84843	35143	1.7
I_3N_1	53200	75815	24366	1.4
I_3N_2	49500	73866	22615	1.5

Data not statistically analyzed.

Main plot: Irrigation scheduling.

I_1 : 0.8 IW/CPE

I_2 : 0.6 IW/CPE

I_3 : 0.4 IW/CPE

Sub plot: Nutrient management practices.

N_1: 75% RDF + 5 t ha^{-1} of charred rice husk.

N_2: 50% RDF + 5 t ha^{-1} of charred rice husk.

N_3: 75% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.

N_4: 50% RDF + 5 t ha^{-1} of charred rice husk along with seed treatment of arbuscular mycorrhiza.

monetary term, would definitely provide higher returns. Similar finding was also reported by (Verma *et al*., 2003).

CONCLUSION

From the present investigation, it can be concluded that irrigation scheduling at 0.8 IW/CPE ratio along with 75% of RDF and 5 tons of charred rice husk as basal with seed treatment of *Arbuscular mycorrhiza* would be an ideal practice for improving water use efficiency, getting higher yield and economic returns.

Conflict of interest

All authors declare that they have no conflicts of interest.

REFERENCES

Ahlawat, I.P.S. and Gangaiah, B. (2010). Response of Bt cotton (*Gossypium hirsutum*) hybrids to irrigation. Indian Journal of Agricultural Science. 80(4): 271-274.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. New Delhi, India. John Wiley: 680 p.

Gouda, S., Kerry, R.G., Samal, D., Mahapatra, G.P., Das, G. and Patra, J.K. (2018). Application of plant growth promoting rhizobacteria in agriculture. Advances in Microbial Biotechnology Current Trends and Future Prospects. Edition: pp 73-83.

Hallikeri, S.S., Halemani, H.L., Patil, V.C., Palled, Y.B., Patil, B.C. and Katageri, I.S. (2009). Influence of sowing time and moisture regimes on growth, seed cotton yield and fibre quality of Bt-cotton. Karnataka Journal of Agricultural Science. 22(5): 985-991.

Hassan, S.F., Shadha, A.A., Layla, I.M. and Musaab, A.Y. (2016). Response of cotton to potassium levels under water regime. International Journal of Applied Agricultural Science. 2(4): 56-63.

Hogan, M.C. (2011). Respiration. In: Encyclopedia of Earth. [(Eds.) Mark McGinley and C.J. Clevel] National Council for Science and the Environment. Occam's razor applied to hormonology: Are cytokinins produced by plants. Plant Physiology. 115: 865-868.

Kannan, P., Ponmani, S., Prabukumar, G. and Swaminathan, C. (2016). Effect of biochar amendment on soil physical, chemical and biological properties and groundnut yield in rainfed Alfisol of semi-arid tropics. Archives of Agronomy and Soil Science. 62(9): 1293-1310.

Sharma, N.K., Williams, W.S. and Zangvil, A. (1984). Formation and structure of silicon carbide whiskers from rice hulls. Journal of the American Ceramic Society. 67(11): 715-720.

Shwetha, M.K., Geethanjali, H.M. and Chowdary, K. (2014). A great opportunity in prospective management of rice husk. International Journal of Commerce and Business Management. 7(1): 176-180.

Srivastra, P. and Chauhan, H.S. (1995). Effect of Irrigation Methods on Cabbage. Orlando, Florida. USA. 899-903.

Verma, C.P., Kedar Prasad, Singh, S.C. and Verma, R.N. (2003). Effect of soil conditioners and fertilizers on yield and economics of maize-wheat sequence. Crop Research. 25(3): 449-453.

Zhang, H., Voroney, R.P. and Price, G.W. (2014). Effects of biochar amendments on soil microbial biomass and activity. Journal of Environmental Quality. 43: 2104-2114.