The Pharma Innovation Journal 2022; 11(4): 1393-1398

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(4): 1393-1398

www.thepharmajournal.com
Received: 02-02-2022
Accepted: 09-03-2022

Sathisha GS
Department of Agronomy, College of Agriculture, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Narayana S Mavarkar
Department of Agronomy, College of Agriculture, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Dinesh Kumar M
Department of Agronomy, College of Agriculture, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Sridhara CJ
Department of Agronomy, College of Agriculture, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Ganapathi
Department of Soil Science and Agricultural Chemistry, College of Agriculture, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Nandish MS
Department of Agricultural Microbiology, College of Agriculture, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Corresponding Author:
Sathisha GS
Department of Agronomy, College of Agriculture, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Influence of drip irrigation levels and varieties on nutrient uptake, nutrient use efficiency and available soil nutrient status of direct seeded rice

Sathisha GS, Narayana S Mavarkar, Dinesh Kumar M, Sridhara CJ, Ganapathi and Nandish MS

Abstract
A field experiment was conducted at Agricultural and Horticultural research station, Bhavikere, Karnataka in red sandy clay loam soil during *summer*-2020 to study the influence of drip irrigation levels and varieties on nutrient uptake, nutrient use efficiency and available soil nutrient status of direct seeded rice. Research was carried out in split plot design consisting of four levels of irrigation in the main plot and four different varieties in sub plot, it was replicated thrice. The experimental results revealed that, scheduling of irrigation at 1.50 IW/CPE ratio recorded higher total N, P and K uptake (107.23, 16.41 and 113.69 kg ha^{-1}) and higher applied N, P and K use efficiency (55.69, 111.37 and 111.37 kg kg^{-1}). Among the varieties used MAS 946-1 recorded higher total N, P and K uptake (110.58, 17.36 and 123.50 kg ha^{-1}) and higher applied N, P and K use efficiency (57.43, 114.87 and 114.87 kg kg^{-1}). Whereas, higher available soil N, P and K was observed in irrigation scheduling at 0.75 IW/CPE ratio (316.13, 33.35 and 227.12 kg ha^{-1}) and among the varieties higher available soil N, P and K was recorded in local variety (326.54, 35.59 and 241.73 kg ha^{-1}).

Keywords: Direct seeded rice, IW/CPE, varieties, nutrients uptake, efficiency and soil nutrients

Introduction

Rice is one of the oldest domesticated grain crop (10,000 years) and is the important energy source for more than 2.5 billion people worldwide. It provides 15 per cent of global human per capita protein and 21 per cent per capita energy. It is grown in majority of the countries, with a total harvested area of about 162.05 m ha, with an annual production of 755.47 m t (USDA, 2019). Rice is cultivated under four major ecosystems *viz.*, irrigated (57%), rainfed lowland (31%), rainfed upland (9%) and deep water (3%). Increased competition for water, reduced investments in irrigation infrastructure, water quality deterioration due to pollution and excessive withdrawals of groundwater are some of the serious threat for sustainable rice production (Lampayan *et al.*, 2015) [14]. These issues seem to be even more severe in the future, however rice production must be significantly increased to meet the food demand despite all these challenges. Therefore, the most viable option is production of more rice with less water that would ensure the food, water, economic and social security of the world.

Cultivation of rice under direct seeded condition provides feasible alternative to traditional rice production allowing significant water savings. In direct seeded rice system, field remains non-flooded throughout the season like an upland crop. This way of growing rice saves water by eliminating continuous seepage, percolation and evaporation apart from wet land preparation (Bouman *et al.*, 2002) [3] thereby considered as a promising cultivation system for water scarce areas.

Adoption of drip irrigation with the proper technique of irrigation scheduling can help to save the amount of water required for the growth and development of direct seeded rice. Where drip irrigation supplies the water precisely and uniformly compared to furrow and sprinkler irrigation method, thus potentially increasing yield, reducing subsurface drainage, providing better salinity control (Hanson and May, 2007) [9]. The growth of rice varieties is likely to differ between upland and lowland conditions and it may also differ with the amount of water supply under upland conditions. Varieties that could maintain water and nutrient uptake under less moist soils may produce larger amounts of dry matter and these varieties would thus become important as the water supply decreases.

Material and Methods

The experiment was conducted at Agricultural and Horticultural Research Station, Bhavikere which is situated between 75°51` E longitude and 13°42` N with an altitude of 695 meters above the mean sea level and is located in Zone-7 of Karnataka. The experiment was laid out in split plot design and comprised of two factors for study *viz.*, Main plot treatments: Irrigation schedules comprised *viz.*, I_1: Irrigation at 0.75 IW/CPE ratio, I_2: Irrigation at 1.00 IW/CPE ratio, I_3: Irrigation at 1.25 IW/CPE ratio and I_4: Irrigation at 1.50 IW/CPE ratio. Subplot treatments: Varieties (M) comprised *viz.*, V_1: Local variety, V_2: Jyothi, V_3: MAS 946-1 and V_4: MAS-26. The varietal description given in the table 1. The gross plot size was 4.8 m × 3.0 m and net plot size was 3.6 m × 2.6 m. The spacing given was 30 cm × 10 cm.

Table 1: Description of the varieties used

Varieties	Duration (days)	Average yield (A) Potential yield (P)	Characteristics and special features
Local variety (Vernacular name: *Buddabatta*)	125-130	A: 35-40 q ha^{-1} P: 55-60 q ha^{-1}	Tall, bold grains with red colour, local variety preserved from time immoral and in use with several farmers for DSR under Shikaripura and Soraba taluk of Shivamogga district of Karnataka
Jyothi	120-125	A: 45-50 q ha^{-1} P: 65-70 q ha^{-1}	Semi dwarf, medium bold grains with red colour, resistance to blast disease.
MAS-26	125-130	A: 60-65 q ha^{-1} P: 85-90 q ha^{-1}	Semi dwarf, medium slender grains, deep rooted, draught and blast resistance.
MAS 946-1	125-130	A: 60-65 q ha^{-1} P: 90-95 q ha^{-1}	Semi dwarf, medium slender grains, deep rooted, draught and blast resistance.

Irrigation was given based on the climatological approach (IW/CPE ratio), where the daily pan evaporation rate was recorded from the standard USWB class A open pan evaporimeter. To apply 5 cm depth of irrigation the cumulative pan evaporation (CPE) has to reach 33.33, 40, 50 and 66.66 mm for 1.50, 1.25, 1.00 and 0.75 IW/CPE ratios, respectively and the irrigation was given through the drip irrigation system. If there is any effective rainfall received it has been deducted from the pre fixed depth of irrigation and waited till CPE reaches the pre fixed depth. By multiplying the depth of irrigation and area of the plot, the volume of water required for each plot was calculated. Where initial 5 cm depth of irrigation was commonly given to all the plots for uniform germination and then the subsequent irrigations scheduled as per the treatment details.

Volume of water required (l) = Depth of irrigation × area of the plot

Time of operation of drip system to deliver required volume of water per plot was computed based on the formula

$$\text{Time of application} = \frac{\text{Volume of water required (l)}}{\text{Emitter discharge (l ha}^{-1}\text{)}\times\text{No. of emitters plot}^{-1}}$$

The soil of the experimental site belongs to red sandy clay loam texture, acidic in soil reaction (5.27) and normal in electrical conductivity (0.15 ds m^{-1}). The organic carbon content was 6.90 g kg^{-1} and medium in available N (282.24 kg ha^{-1}), medium in available phosphorus (22.12 kg P_2O_5 ha^{-1}) and medium in available potassium (227.52 kg K_2O ha^{-1}), DTPA extractable zinc (0.89 mg kg^{-1}) and DTPA extractable iron (16.78 mg kg^{-1}). The data was statistically analysed as per the procedure given by Gomez and Gomez (1984). Nitrogen, phosphorous and potassium content in rice grain and straw was determined by modified micro kjeldhal method as prescribed by Jackson (1973), Vanadomolybdate phosphoric acid yellow color method and absorbance of the solution was recorded at 420 nm using spectrophotometer (Jackson, 1967) and flame photometer method (Jackson, 1967), respectively and expressed on percentage and finally uptake of nutrient was calculated and expressed in kg ha^{-1}.

$$\text{Nutrient uptake by grain (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%)}\times\text{ dry weight of grain (kg ha}^{-1}\text{)}}{100}$$

$$\text{Nutrient uptake by straw (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%)}\times\text{ dry weight of straw (kg ha}^{-1}\text{)}}{100}$$

Total nutrient uptake = Nutrient uptake by grain + Nutrient uptake by straw

Nutrient use efficiency was calculated by using following formula and expressed in kg kg^{-1} (Crasswell and Godwin, 1984).

$$\text{NUE} = \frac{\text{Grain yield (kg ha}^{-1}\text{)}}{\text{Nutrient applied (kg ha}^{-1}\text{)}}\times 100$$

Results and Discussion

Grain and straw yield of direct seeded rice as influenced by the levels of irrigation schedules and varieties

Grain yield, straw yield and harvest index of direct seeded rice as influenced by scheduling of irrigation and varieties are presented in the Table.

Grain yield and straw yield was significantly influenced by irrigation schedules. Results indicated that grain and straw yield increased with the increase in levels of irrigation schedules. Grain yield and straw yield was found significantly higher in scheduling of irrigation at 1.50 IW/CPE ratio (5569 kg ha^{-1} and 7514 kg ha^{-1}, respectively) and it was on par with 1.25 IW/CPE ratio (5268 kg ha^{-1} and 7162 kg ha^{-1}, respectively). Scheduling of irrigation at 0.75 IW/CPE ratio recorded significantly lower grain and straw yield (4143 kg ha^{-1} and 5812 kg ha^{-1}, respectively).

The higher grain yield was recorded with higher levels of the irrigation regimes might be due to the higher growth and yield attributes as well conducive situation for efficient water and nutrients uptake which boost their growth and yield attributes through supply of more photosynthates towards the reproductive sink. The similar results of reduced levels of irrigation on reduction in grain yield are reported by Akinbile, 2011 [1], Govindan and Grace, 2012 [7], Gururaj, 2013 [8], Nagaraju *et al.* 2014 [17], Ramanamurthy *et al.*, 2017 [23], Keerthi *et al.*, 2018 [13], Padmaja and Mallareddy, 2019 [19].

The decreased straw yield under the reduced levels of irrigation may be due to low moisture stress induced impaired tillering due to accelerated leaf senescence and hence decreased photosynthetic area under moisture stress leading to the lower dry matter production and consequently reduced straw yield. Whereas higher levels of irrigation helps to increase the plant height and production of number of tillers which resulted in improvement of biomass production that ultimately reflected the straw yield. The similar findings were made by Govindan and Myrtle Grace, 2012 [7], Ramamurthy and Reddy, 2013 [22], Anusha, 2015 [2], Ramanamurthy *et al.*, 2017 [23], Keerthi *et al.*, 2018 [13], Padmaja and Malla reddy, 2019 [19].

Varieties of rice significantly influenced the grain and straw yield. Significantly higher grain and straw yield was recorded in MAS 946-1 variety (5743 kg ha^{-1} and 7228 kg ha^{-1}, respectively) and it was on par with MAS-26 (5614 kg ha^{-1} and 6988 kg ha^{-1}, respectively). Significantly lower grain yield (3463 kg ha^{-1}) was recorded in local variety and lower straw yield was recorded in Jyothi variety (6221 kg ha^{-1}).

Yield increase in the varieties was mainly due to the potential genetic makeup the variety helps for the increased uptake and utilization of the applied nutrients effectively resulting in enhanced growth and yield attributes promotes the increased photosynthetic efficiency of the variety leading to greater dry matter production and translocation to sink. Results which shows the significant variation ion grain yield among the varieties reported by Singh and Sridevi (2006) [24], Sridhara (2008) [25], Veeresh *et al.* (2011) [28], Ramachandra *et al.* (2015) [21], Sritharan *et al.* (2015) [26], Yadav *et al.* (2017) [29], Dawadi and Chaudary (2018) [5] and Joseph *et al.* (2019) [12].

Nitrogen, Phosphorous and Potassium uptake of direct seeded rice as influenced by drip irrigation schedules and varieties

Data pertaining to the influence of irrigation schedules and varieties on N, P and K uptake of direct seeded rice is presented in the Table.

NPK uptake was significantly influenced by different irrigation schedules. Results indicated that NPK uptake increased with the increase in levels of irrigation schedule. Total N, P and K uptake was found significantly higher in 1.50 IW/CPE ratio (107.23, 16.41 and 113.69 kg ha^{-1}, respectively) and it was at par with the 1.25 IW/CPE ratio (101.64, 15.60 and 108.72 kg ha^{-1}, respectively). Wherein, scheduling of irrigation at 0.75 IW/CPE ratio recorded significantly lower total N P and K uptake (80.87, 12.37 and 87.38 kg ha^{-1}, respectively).

Among the verities, MAS 946-1 recorded significantly higher total N, P and K uptake (110.58, 17.36 and 123.50 kg ha^{-1}, respectively) and it was on par with the MAS-26 (109.34, 17.08 and 118.07 kg ha^{-1}, respectively). Significantly lower total N P and K uptake (70.46, 10.13 and 72.77 kg ha^{-1}, respectively) was recorded in local variety.

Nutrient uptake is the function of total biomass production and nutrient content in the biomass and total nutrient uptake is the sum of uptake by grain and straw. Significantly higher nutrient uptake in grain, straw and total nutrient uptake was recorded in irrigation scheduling at 1.50 IW/CPE ratio and it was on par with the 1.25 IW/CPE ratio. The increased uptake of nutrients at higher levels of irrigation resulted in initial build up of vigorous growth and higher photosynthetic rate, leading to better uptake of nutrients throughout the crop growth period results in increased nutrient accumulation in plants. Increased yield levels with higher levels of irrigation and more nutrient concentration might have resulted in increased nutrient uptake. The results are in conformity with the findings of the Mahajan *et al.*, 2012 [15], Murthy and Reddy, 2013 [16], Nayak *et al.*, 2016 [18] and Ramanamurthy *et al.*, 2017 [23].

The differential uptake of nutrients in the grain, straw among the varieties due the differences in the yield with varied in nutrient accumulation. The varieties with higher biomass and nutrient concentration has achieved significantly higher nutrient uptake.

Nutrient use efficiency (kg kg^{-1}) of direct seeded rice as influenced by irrigation schedules and varieties

The data on nutrient use efficiency as influenced by effect of irrigation schedules and varieties in direct seeded rice is represented in the Table.

Among the irrigation schedules, scheduling of irrigation at 1.50 IW/CPE ratio recorded significantly higher nitrogen, phosphorus and potassium use efficiency (55.69, 111.37 and 111.37 kg kg^{-1}, respectively) and it was on par with 1.25 IW/CPE ratio (52.68, 105.36 and 105.36 kg kg^{-1}, respectively). While, significantly lower nitrogen, phosphorus and potassium use efficiency (41.43, 82.87 and 82.87 kg kg^{-1}, respectively) was recorded in 0.75 IW/CPE ratio.

With respect to the varieties, MAS 946-1 recorded significantly higher nitrogen, phosphorus and potassium use efficiency (57.43, 114.87 and 114.87 kg kg^{-1}, respectively) and it was on par with MAS-26 (56.14, 112.28 and 112.28 kg kg^{-1}, respectively). Significantly lower nitrogen, phosphorus and potassium use efficiency (34.63, 69.27 and 69.27 kg kg^{-1}, respectively) local variety.

The increased nutrient use efficiency at the higher levels of irrigation might be due to the better availability of moisture makes the nutrients more soluble and easily available throughout the crop growth stages leading to better uptake of nutrients, production of higher dry matter and in turn better nutrient use efficiency (Prasad *et al.*, 2016) [20].

The MAS 946-1 variety achieved significantly higher nutrient use efficiency and it was on par with the MAS-26. This could be due to the varietal performance and genetic makeup the variety determines better crop growth and development in turn utilisation of the applied nutrients effectively.

Available soil N, P and K status at harvest as influenced by the drip irrigation schedule and varieties

Data pertaining to the available nutrient status of soil at harvest such as available nitrogen, phosphorus and potassium as influenced by the irrigation schedules and varieties in direct seeded rice are presented in the Table.

Available nutrient status *viz.*, nitrogen, phosphorous and potassium at harvest was found non significant difference among the irrigation schedules.

The varieties recorded significant variation with respect to the available nutrient status in soil at harvest. The local variety recorded significantly higher available nitrogen, phosphorous and potassium (326.54, 35.59 and 241.73 kg ha^{-1}, respectively) and significantly lower available nitrogen, phosphorous and potassium (286.42, 28.36 and 191.00 kg ha^{-1}, respectively) was recorded in MAS 946-1. This could be due to the lower crop growth and development makes the reduced utilisation and build up of applied nutrients which makes more available nutrients in case of the local variety.

Table 2: Grain yield, straw yield and harvest index of direct seeded rice as influenced by irrigation schedules and varieties

	Grain yield (kg ha^{-1})					Straw yield (kg ha^{-1})					Harvest index				
	I_1	I_2	I_3	I_4	Mean	I_1	I_2	I_3	I_4	Mean	I_1	I_2	I_3	I_4	Mean
V_1	2962^{i}	3214^{hi}	3655^{gh}	4022^{fg}	3463	5750^{gh}	6239^{defg}	6788^{cdef}	7469^{abc}	6561	0.34^{b}	0.34^{b}	0.35^{b}	0.35^{b}	0.34
V_2	3976^{fg}	4429^{ef}	5117^{bcd}	5488^{b}	4753	5271^{h}	6116^{fg}	6513^{def}	6985^{bcd}	6221	0.43^{a}	0.42^{a}	0.44^{a}	0.44^{a}	0.43
V_3	4877^{cde}	5420^{b}	6201^{a}	6475^{a}	5743	6207^{efg}	6898^{cde}	7892^{a}	7914^{a}	7228	0.44^{a}	0.44^{a}	0.44^{a}	0.45^{a}	0.44
V_4	4758de	5309^{bc}	6099^{a}	6289^{a}	5614	6056^{fgh}	6757^{cdef}	7454^{abc}	7687^{ab}	6988	0.44^{a}	0.44^{a}	0.45^{a}	0.45^{a}	0.45
Mean	4143	4593	5268	5569		5821	6503	7162	7514		0.41	0.41	0.42	0.42	

	S.Em.±	CD (P=0.05)	S.Em.±	CD (P=0.05)	S.Em.±	CD (P=0.05)
Main plot (I)	109	376	163	564	0.002	NS
Sub plot (V)	76	220	83	244	0.005	0.014
Interaction (IXV)	152	NS	229	NS	0.010	NS

Main plot: Irrigation scheduling (I) Sub plot: Varieties (V)
I_1: Irrigation at 0.75 IW/CPE ratio V_1: Local variety
I_2: Irrigation at 1.00 IW/CPE ratio V_2: Jyothi
I_3: Irrigation at 1.25 IW/CPE ratio V_3: MAS 946-1
I_4: Irrigation at 1.50 IW/CPE ratio V_4: MAS-26

Table 3: Nitrogen uptake of direct seeded rice as influenced by irrigation schedules and varieties

	N uptake in grain (kg ha^{-1})					N uptake in straw (kg ha^{-1})					Total N uptake (kg ha^{-1})				
	I_1	I_2	I_3	I_4	Mean	I_1	I_2	I_3	I_4	Mean	I_1	I_2	I_3	I_4	Mean
V_1	37.03	40.14	45.49	50.24	43.23	23.92	25.91	28.11	31.00	27.24	60.95	66.05	73.60	81.24	70.46
V_2	50.15	55.84	64.42	69.08	59.87	24.86	28.85	30.70	32.92	29.33	75.01	84.69	95.12	102.01	89.20
V_3	64.49	71.48	82.06	85.73	75.94	29.74	33.03	37.84	37.97	34.64	94.23	104.51	119.90	123.69	110.58
V_4	63.65	71.07	81.48	84.30	75.12	29.64	33.09	36.46	37.67	34.22	93.30	104.16	117.94	121.97	109.34
Mean	53.83	59.63	68.36	72.34		27.04	30.22	33.28	34.89		80.87	89.85	101.64	107.23	

	S.Em.±	CD (P=0.05)	S.Em.±	CD (P=0.05)	S.Em.±	CD (P=0.05)
Main plot (I)	1.43	4.96	0.71	2.47	2.14	7.39
Sub plot (V)	1.31	3.82	0.50	1.45	1.64	4.80
Interaction (IXV)	2.62	NS	1.00	NS	3.29	NS

Main plot: Irrigation scheduling (I) Sub plot: Varieties (V)
I_1: Irrigation at 0.75 IW/CPE ratio V_1: Local variety
I_2: Irrigation at 1.00 IW/CPE ratio V_2: Jyothi
I_3: Irrigation at 1.25 IW/CPE ratio V_3: MAS 946-1
I_4: Irrigation at 1.50 IW/CPE ratio V_4: MAS-26

Table 4: Phosphorous uptake of direct seeded rice as influenced by irrigation schedules and varieties

	P uptake in grain (kg ha^{-1})					P uptake in straw (kg ha^{-1})					Total P uptake (kg ha^{-1})				
	I_1	I_2	I_3	I_4	Mean	I_1	I_2	I_3	I_4	Mean	I_1	I_2	I_3	I_4	Mean
V_1	5.50	5.97	6.82	7.47	6.44	3.22	3.50	3.83	4.19	3.69	8.72	9.48	10.65	11.67	10.13
V_2	8.28	9.23	10.66	11.43	9.90	3.10	3.59	3.82	4.10	3.65	11.39	12.82	14.48	15.53	13.56
V_3	11.14	12.35	14.15	14.76	13.10	3.66	4.06	4.65	4.66	4.26	14.80	16.41	18.80	19.42	17.36
V_4	10.96	12.22	14.05	14.46	12.92	3.60	4.02	4.44	4.58	4.16	14.57	16.24	18.48	19.04	17.08
Mean	8.97	9.94	11.42	12.03		3.40	3.80	4.19	4.38		12.37	13.74	15.60	16.41	

	S.Em.±	CD (P=0.05)	S.Em.±	CD (P=0.05)	S.Em.±	CD (P=0.05)
Main plot (I)	0.23	0.79	0.09	0.32	0.32	1.11
Sub plot (V)	0.17	0.49	0.07	0.22	0.23	0.66
Interaction (IXV)	0.34	NS	0.15	NS	0.45	NS

Main plot: Irrigation scheduling (I) Sub plot: Varieties (V)
I_1: Irrigation at 0.75 IW/CPE ratio V_1: Local variety
I_2: Irrigation at 1.00 IW/CPE ratio V_2: Jyothi
I_3: Irrigation at 1.25 IW/CPE ratio V_3: MAS 946-1
I_4: Irrigation at 1.50 IW/CPE ratio V_4: MAS-26

Table 5: Potassium uptake of direct seeded rice as influenced by irrigation schedules and varieties

	K uptake in grain (kg ha^{-1})					K uptake in straw (kg ha^{-1})					Total K uptake (kg ha^{-1})				
	I_1	I_2	I_3	I_4	Mean	I_1	I_2	I_3	I_4	Mean	I_1	I_2	I_3	I_4	Mean
V_1	13.39	14.55	16.61	18.20	15.69	49.98	54.26	59.17	64.92	57.08	63.37	68.81	75.77	83.12	72.77
V_2	19.93	22.20	25.64	27.50	23.82	58.50	67.92	72.33	77.57	69.08	78.42	90.11	97.98	105.07	92.90
V_3	26.75	29.67	33.99	35.45	31.46	79.13	87.73	100.55	100.75	92.04	105.88	117.40	134.54	136.20	123.50

V_4	26.03	29.01	33.34	34.33	30.68	75.81	84.50	93.23	96.05	87.40	101.83	113.50	126.57	130.38	118.07
Mean	21.53	23.86	27.40	28.87		65.85	73.60	81.32	84.82		87.38	97.45	108.72	113.69	
		S.Em.±		CD (P=0.05)		S.Em.±			CD (P=0.05)		S.Em.±			CD (P=0.05)	
Main plot (I)		0.55		1.89		1.68			5.80		2.22			7.68	
Sub plot (V)		0.40		1.17		1.19			3.48		1.57			4.59	
Interaction (IXV)		0.80		NS		2.38			NS		3.15			NS	

Main plot: Irrigation scheduling (I) Sub plot: Varieties (V)

I_1: Irrigation at 0.75 IW/CPE ratio V_1: Local variety
I_2: Irrigation at 1.00 IW/CPE ratio V_2: Jyothi
I_3: Irrigation at 1.25 IW/CPE ratio V_3: MAS 946-1
I_4: Irrigation at 1.50 IW/CPE ratio V_4: MAS-26

Table 6: Nutrient use efficiency (kg kg^{-1}) of direct seeded rice as influenced by irrigation schedules and varieties

	Nitrogen					**Phosphorous**					**Potassium**				
	I_1	**I_2**	**I_3**	**I_4**	**Mean**	**I_1**	**I_2**	**I_3**	**I_4**	**Mean**	**I_1**	**I_2**	**I_3**	**I_4**	**Mean**
V_1	29.62	32.14	36.55	40.22	34.63	59.24	64.28	73.10	80.44	69.27	59.24	64.28	73.10	80.44	69.27
V_2	39.76	44.29	51.17	54.88	47.53	79.52	88.58	102.34	109.76	95.05	79.52	88.58	102.34	109.76	95.05
V_3	48.77	54.20	62.01	64.75	57.43	97.54	108.40	124.02	129.50	114.87	97.54	108.40	124.02	129.50	114.87
V_4	47.58	53.09	60.99	62.89	56.14	95.16	106.18	121.98	125.78	112.28	95.16	106.18	121.98	125.78	112.28
Mean	41.43	45.93	52.68	55.69		82.87	91.86	105.36	111.37		82.87	91.86	105.36	111.37	
		S.Em.±		CD (P=0.05)		S.Em.±			CD (P=0.05)		S.Em.±			CD (P=0.05)	
Main plot (I)		1.09		3.76		2.17			7.52		2.17			7.52	
Sub plot (V)		0.76		2.21		1.52			4.43		1.52			4.43	
Interaction (IXV)		1.52		NS		3.03			NS		3.03			NS	

Main plot: Irrigation scheduling (I) Sub plot: Varieties (V)

I_1: Irrigation at 0.75 IW/CPE ratio V_1: Local variety
I_2: Irrigation at 1.00 IW/CPE ratio V_2: Jyothi
I_3: Irrigation at 1.25 IW/CPE ratio V_3: MAS 946-1
I_4: Irrigation at 1.50 IW/CPE ratio V_4: MAS-26

Table 7: Available N. P_2O_5 and K_2O status of soil at harvest under direct seeded rice as influenced by irrigation schedules and varieties

	Available N (kg ha^{-1})					**Available P_2O_5 (kg ha^{-1})**					**Available K_2O (kg ha^{-1})**				
	I_1	**I_2**	**I_3**	**I_4**	**Mean**	**I_1**	**I_2**	**I_3**	**I_4**	**Mean**	**I_1**	**I_2**	**I_3**	**I_4**	**Mean**
V_1	336.05	330.95	323.40	315.76	326.54	37.00	36.24	35.07	34.05	35.59	251.13	245.69	238.73	231.38	241.73
V_2	321.99	312.31	301.88	294.99	307.80	34.33	32.90	31.24	30.19	32.16	236.08	224.39	216.52	209.43	221.60
V_3	302.77	292.49	277.10	273.31	286.42	30.92	29.31	26.92	26.30	28.36	208.62	197.10	179.96	178.30	191.00
V_4	303.70	292.84	279.06	275.03	287.66	31.15	29.48	27.24	26.68	28.64	212.67	201.00	187.93	184.12	196.43
Mean	316.13	307.15	295.36	289.77		33.35	31.98	30.12	29.31		227.12	217.05	205.78	200.81	
		S.Em.±		CD (P=0.05)		S.Em.±			CD (P=0.05)		S.Em.±			CD (P=0.05)	
Main plot (I)		7.04		NS		0.74			NS		5.01			NS	
Sub plot (V)		5.63		16.43		0.60			1.75		4.07			11.88	
Interaction (IXV)		11.26		NS		1.20			NS		8.14			NS	

Main plot: Irrigation scheduling (I) Sub plot: Varieties (V)

I_1: Irrigation at 0.75 IW/CPE ratio V_1: Local variety
I_2: Irrigation at 1.00 IW/CPE ratio V_2: Jyothi
I_3: Irrigation at 1.25 IW/CPE ratio V_3: MAS 946-1
I_4: Irrigation at 1.50 IW/CPE ratio V_4: MAS-26

Initial nutrient status: N: P_2O_5: K_2O 282.24:22.12:227.52 kg ha^{-1}.

Conclusion

The study revealed that scheduling of irrigation at higher levels recorded highest uptake of the applied nutrients with higher use efficiency. Among the varieties used for direct seeded rice, highest uptake of the applied nutrients with higher use efficiency was recorded in MAS 946-1 and lowest was found in the local variety of rice.

References

1. Akinbile CO. Crop water use responses of upland rice to differential water distribution under sprinkler irrigation system. Advances in App. Sci. Res. 2011;1(1):133-144.
2. Anusha S. Studies on drip fertigation in aerobic rice (*Oryza sativa* L.). Ph.D. (Agri.) Thesis, Univ. Agril. Sci., Bengaluru, 2015.
3. Bouman BAM, Wang Hua QI, Yang XG, Zhao JF, Wang CG. Aerobic rice (Han Dao): a new way of growing rice in water short areas. In: Proceeding of the 12th Inter. Soil Conser. Organ. Conf., May 26-31, Beijing, China. Tsinghua University Press, 2002, 175-181.
4. Crasswell ET, Godwin DC. The efficiency of nitrogen fertilizers applied to cereals in different climates. In: Advances in plant nutrition. New York, 1984, 55.
5. Dawadi KP, Chaudhary NK. Effect of sowing dates and varieties on yield and yield attributes of direct seeded rice in chitwan condition. The J Agric. and Env. 2018;14:121-130.
6. Gomez KA, Gomez AA. In: Statistical procedures for agricultural research. Second Edn. John Wiley and Sons, New York, 1984, 68.

7. Govindan R, Grace T. Influence of drip fertigation on growth and yield of rice varieties (*Oryza sativa* L.). Madras Agric. J. 2012;99(4-6):244-247.
8. Gururaj K. Optimization of water and nutrient requirement through drip fertigation in aerobic rice. M.Sc. (Agri.) Thesis, Univ. of Agril. Sci., Bengaluru, 2013.
9. Hanson BR, May DM. The effect of drip line placement on yield and quality of drip irrigated processing tomatoes. Irrigation Drainage Systems. 2007;21:109-118.
10. Jackson ML. Soil chemical analysis, (Ed.). Prentice Hall of India Pvt. Ltd., New Delhi, 1967, 183-192.
11. Jackson ML. Soil Chemical Analysis. Prentice Hall of India. Pvt. Ltd., New Delhi, 1973, 498.
12. Joseph KR, Monicadevi N, Priyadevi K, Gogoi M, Anal PS, Effect of variety and spacing on the productivity of direct seeded rice (*Oryza sativa* L.) under Manipur condition. Ind. J Pure App. Biosci. 2019;7(5):335-341.
13. Keerthi MM, Babu R, Nagalingam SV, Venkataraman NS, Karunanandham K. Effect of varied irrigation scheduling with levels and times of nitrogen application on yield and water use efficiency of aerobic rice. American J Plant Sci. 2018;9(10):2287-2296.
14. Lampayan RM, Rejesus RM, Singleton GR, Bouman B. Adoption and economics of alternate wetting and drying water management for irrigated lowland rice. Field Crops Res. 2015;170(5):95-108.
15. Mahajan G, Chauhan BS, Timsina J, Singh PP, Singh K. Crop performance and water and nitrogen use efficiencies in dry-seeded rice in response to irrigation and fertilizer amounts in Northwest India. Field Crops Res. 2012;134:59-70.
16. Murthy KVR, Reddy DS, Effect of irrigation and weed management practices on nutrient uptake and economics of aerobic rice. J Agric. and Vet. Sci. 2013;3(1):15-21.
17. Nagaraju Anusha S, Kombali G, Rekha B, Sheshadri T, Shankar MA. Drip irrigation and fertigation: an alternate strategy to improve production and water productivity of rice. In: Proceedings of National symposium on Agricultural diversification for sustainable livelihood and environment security. November 18-20, Punjab Agricultural University, Ludhiana, 2014.
18. Nayak BD, Murthy KR, Anitha KV. Economics of drip fertigation in aerobic rice as influenced by levels of irrigation and fertigation. Adv. Life Sci. 2016;5(2):400-402.
19. Padmaja B, Mallareddy M. Drip irrigation and fertigation effects on aerobic rice (*Oryza sativa*) in semi-arid conditions of Telangana state, India. Int. J Curr. Microbiol. App. Sci. 2019;7(8):1156-1171.
20. Prasada RV, Venkateswarlu B, Yadav B, Rao AS, Rao KLN, Rani P. Effect of sub surface drip fertigation on water productivity, nitrogen use efficiency and economics of aerobic rice. Plant Archives. 2016;16(2):855-858.
21. Ramachandra C, Shivakumar N, Rajanna MP, Krishnamurthy R, Ningaraju GK. Studies on response of rice varieties and different dates of sowing on productivity of aerobic rice. Res. on Seasons. 2015;16(6):15-20.
22. Ramanamurthy KV, Reddy DS. Effect of irrigation and weed management practices on nutrient uptake and economics of production of aerobic rice. J Agric. and Veterinary Sci. 2013;3(3):2319-2372.
23. Ramanamurthy KV, Ramadass S, Ramanathan SP. Effect of irrigation and nitrogen levels on the growth, yield and economics of rice. J Curr. Microbiol. App. Sci. 2017;4(2):280-292.
24. Singh S, Sridevi B. Genotypic variation among the varieties of rice. Indian J Agron. 2006;50(1):228-231.
25. Sridhara CJ. Effect of genotypes, planting geometry, methods of establishment and micronutrient application on growth and yield of aerobic rice. Ph.D. Thesis, Univ. of Agril. Sci., Bengaluru, 2008.
26. Sritharan N, Vijayalakshmi C, Subramanian E, Boomiraj K. Supremacy of rice genotypes under aerobic condition for mitigating water scarcity and future climate change. Afr. J Agric. Res. 2015;10(4):235-243.
27. USDA [United States Department of Agriculture]. 2019, World: Rice Area, yield and production[online]. Available: http://apps.fas.usda.gov/psdoline/reportHandlr.ashx?.
28. Veeresh Desai BK, Vishwanatha S, Anilkumar SN, Rao S, Halepyati AS. Growth and yield of rice (*oryza sativa* L.) varieties as influenced by different methods of planting under aerobic method of cultivation. Research J Agric. Sci. 2011;2(2):298-300.
29. Yadav Singh DK, Chaudharys, Kumar A, Anilnath. Growth and yield attributes of direct seeded aerobic rice (*Oryza sativa* L.) as influenced by seed rate and varieties. Int. J Curr. Microbiol. App. Sci. 2017;6(2):868-873.