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Precision Management Practices - A Much Needed Set of Agro-Techniques to Improve Rice Productivity and Cutback the Resources in Aerobic Condition under Drip Irrigation

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A B S T R A C T

A field experiment was conducted to assess the precision management practices on agronomic efficiency, grain yield, water productivity and economics of aerobic rice during summer 2016 and *kharif* 2016. Treatments comprising two nutrient management practices, three planting geometry and two water management practices with one control (soil application of fertilizer dose and drip irrigation) and one absolute control (No RDF and drip irrigation). The results revealed that, among interactions between nutrient management, planting geometry and water management, application of 25% N&K from sowing to 30 DAS + 25% N&K from 31 to 50 DAS + 25% N&K from 51 to 80 DAS + 25% N&K from 81 to 105 DAS with planting geometry of 25×15 cm and drip irrigation scheduling at 125% PE up to tillering + 150% PE from tillering to PI + 200% PE from PI to physiological maturity recorded significant grain yield (8.56 t ha^{-1}), agronomic efficiency of nitrogen, phosphorus & potassium (62.87, 125.74 and 125.74 kg kg^{-1}, respectively) and net returns & B:C ratio (□ 82,853 and 2.47, respectively) than soil application of fertilizers in aerobic rice.

Keywords

Precision management practices, Aerobic rice, Planting geometry, Drip irrigation.

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Introduction

World agriculture is facing one of the largest challenges in the 21st century: how to produce enough food to feed 9 billion people by 2050, with limited land, water and nutrient resources, and reduce negative environmental harm simultaneously for sustainable development (Tilman *et al.*, 2011). This calls for a new paradigm of sustainable intensification of agriculture to close "yield gaps" of underperforming lands and increase resource use efficiencies simultaneously (Shen *et al.*, 2013). Precision agriculture (PA) has been listed as one of the top ten revolutions in agriculture for the past 50 years (Crookston, 2006). It can be defined as an integrated information- and technology-based agricultural management system, with the intent to manage spatial and temporal variability associated with all aspects of agricultural production for optimum profitability, sustainability and protection of the environment (Miao *et al.*, 2006). It has been regarded as a promising strategy that can make significant contributions to both food security and sustainable development (Mueller *et al.,* 2012). However, such precision agricultural systems do not exist yet and most PA research to date has mainly focused on nutrient (Peng *et al.*, 2010), water (Hedley and Yule, 2009) and pesticide (Mahlein *et al.,* 2012) management to improve resource use efficiencies. Such systems generally maintained or slightly increased crop yields.

Precision management practices that combine different management components into high yield and high efficiency crop management systems are urgently needed. Taking rice (*Oryza sativa* L.) as an example, this study was conducted to develop a set of agro-techniques to improve rice productivity.

Rice is the staple food for more than 3 billion people in the world, making it the most important food crop for human consumption and food security (Cantrell and Teeves, 2002). To meet the consumption needs of the growing population, global average rice yield needs to be increased by 12% over the yield level of 2005 by 2015 (Normile, 2008). Asia harvests about 90% of the world's rice, however, Asia has not seen any rice yield increase in the past decade (Normile, 2008). Large yield gaps (2–5 t ha^{-1}) have been found in four Southeast Asian countries (Laborte *et al.,* 2012). Unsuitable rates as well as wrong timing of nutrients application have resulted in very low nutrient use efficiency for rice (Peng *et al.,* 2010).

Another great challenge for rice farming is water scarcity. Irrigated rice accounts for about 80% of the total fresh water resources used for irrigation in Asia, but the current water use efficiency for rice is about two times smaller than wheat (Bouman *et al.,* 2007). Further, due to urbanization there is no scope to increase the rice growing area so, need to intensify the crop in the available rice growing area. Keeping above facts in mind, the study was conducted with the objective to study the effect of precision management practices on agronomic efficiency, water productivity, grain yield and economics of drip irrigated aerobic rice.

Materials and Methods

A field experiment was conducted at Zonal Agricultural Research Station, University of Agricultural Sciences, Bengaluru during summer 2016 and *kharif* 2016. The site is located at 13^0 05' 21" N latitude and 77^0 34' 02" E longitude with an altitude of 947 m above mean sea level. The soil of the experimental site was sandy loam. The initial soil pH was 5.93 and electrical conductivity was 0.34 dSm^{-1}. Available nitrogen, phosphorus and potassium were 319.3, 28.4 and 293.0 kg ha^{-1}, respectively. The experiment was laid out in Randomized Complete Block Design with factorial concept (FRCBD) and replicated thrice.

Two nutrient management practices (N_1: 50% N&K from sowing to 30 DAS + 25% N&K from 31 to 50 DAS + 25% N&K from 51 to 80 DAS and N_2:25% N&K from sowing to 30 DAS +25% N&K from 31 to 50 DAS + 25% N&K from 51 to 80 DAS + 25% N&K from 81 to 105 DAS), three planting geometry (P_1: 25×25 cm, P_2: 25×20 cm and P_3: 25×15 cm) and two water management practices (I_1: Drip irrigation at 125% PE up to tillering + 150% PE from tillering to PI + 200% PE from PI to physiological maturity and I_2: Drip irrigation at 100% PE up to tillering + 125% PE from tillering to PI + 150% PE from PI to physiological maturity) with one control (Recommended plant population and soil application of fertilizer dose with drip irrigation) and one absolute control (no RDF and drip irrigation) were included in this study.

The land was brought to fine tilth before sowing by ploughing twice with tractor drawn disc plough and passing cultivator and two harrowing. Seeds of MAS 946-1 rice variety were dibbled at 2 per hill by following spacing of 25cm × 25cm, 25cm × 20cm and 25cm × 15cm as per the treatment with seed rate of 5 kg ha^{-1}. FYM at 10 tonnes ha^{-1} was applied two weeks before sowing. Nutrients were applied through fertigation, drip fertigation system included pump, filter units, fertigation tank, ventury, main line and sub line. The required fertilizer nutrients were calculated and were applied as per treatments whereas phosphorous was applied in two equal splits (50 per cent as basal and remaining 50 per cent at 30 DAS) uniform to all the treatments. The recommended dose of fertilizer was 125:62.5:62.5 kg N, P_2O_5 and K_2O ha^{-1} during summer 2016 and 100:50:50 kg N, P_2O_5 and K_2O ha^{-1} during *kharif* 2016. Pre-sowing irrigation was uniformly given to all treatments. Irrigation was provided through laterals separated at 50 cm apart in alternative rows. Inline emitters were at 40 cm apart with discharge rate of 3 lph. According to treatments drip irrigation was scheduled every day based on pan evaporation (Epan) and the quantity of water was calculated as follows;

$$\text{Volume (l ha}^{-1}\text{)} = \text{Epan} \times \text{Kp} \times \text{Area (m}^2\text{)}$$

Where,
Epan= Pan evaporation
K_p = Pan factor (0.80)

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

$$\text{Time of Application (hr)} = \frac{\text{Volume of water required (l plot}^{-1}\text{)}}{\text{Emitter dicharge (lph)} \times \text{No. of emitters plot}^{-1}}$$

For control and absolute control drip irrigation was scheduled at 150 per cent pan evaporation throughout all the growth stages. As per treatment requirement fertigation was provided and the fertigation was scheduled at once in four days. Nitrogen and potassium were supplied through urea (46 % N) and sulphate of potash (50 % K_2O). However for control, muriate of potash used as potassium source and SSP as phosphorus source (for all the treatments). Londax power (Bensulfuron methyl 0.6% + Pretilachlor 6% GR) at 10 kg ha^{-1} was applied at 2 DAS as pre-emergence herbicide. Plant population was maintained according to the treatment by thinning excess seedlings at 21 DAS leaving one seedling per hill. Healthy crop stand was ensured by adopting need based plant protection and recommended package of practices. The Agronomic efficiency of nitrogen, phosphorus and potassium was calculated by using the formula:

$$\text{AE (kg kg}^{-1}\text{)} = \frac{\text{(Grain yield in treatment plot – Grain yield in absolute control plot) (kg ha}^{-1}\text{)}}{\text{Nutrient applied (kg ha}^{-1}\text{)}}$$

The quantity of water used by each treatment was calculated based on effective rainfall and open pan evaporation. The WUE was calculated by using following formula:

$$\text{WUE (kg ha-cm}^{-1}\text{)} = \frac{\text{Grain yield (kg ha}^{-1}\text{)}}{\text{Quantity of total water applied (cm)}}$$

The cost of various inputs used and the prices of outputs in the prevailing local markets were considered for cost of cultivation, gross returns and net returns per hectare.

Net returns were calculated by deducting the cost of cultivation from total gross returns. Benefit-cost ratio was worked as fallows,

$$\text{B: C ratio} = \frac{\text{Gross returns (Rs. ha}^{-1})}{\text{Cost of cultivation (Rs. ha}^{-1})}$$

All the data were analyzed and the results are presented and discussed at a probability level of 5 per cent.

Results and Discussion

Agronomic efficiency

Application of 25% N & K from sowing to 30 DAS + 25% N & K from 31 to 50 DAS + 25% N & K from 51 to 80 DAS + 25% N & K from 81 to 105 DAS recorded significantly higher agronomic efficiency of nitrogen, phosphorus and potassium in pooled data (50.85, 104.60 and 101.70 kg kg^{-1}, respectively) and resembling trend in first (49.40, 98.80 and 98.80 kg kg^{-1}, respectively) and second season (52.30, 104.60 and 104.60 kg kg^{-1}, respectively). Significantly lower agronomic efficiency of nitrogen, phosphorus and potassium by aerobic rice were noticed in application of 50% N & K from sowing to 30 DAS + 25% N & K from 31 to 50 DAS + 25% N & K from 51 to 80 DAS (26.77, 53.55 and 53.55 kg kg^{-1}, respectively). Agronomic efficiency of nitrogen, phosphorus and potassium also varied significantly due to different planting geometry. Pooled analysis indicated, significantly higher agronomic efficiency of nitrogen, phosphorus and potassium were observed (46.91, 93.83 and 93.83 kg kg^{-1}, respectively) in planting geometry of 25×15 cm and similar trend in first (45.38, 90.77 and 90.77 kg kg^{-1}, respectively) and second season (48.44, 96.88 and 96.88 kg kg^{-1}, respectively). Planting geometry of 25×25 cm recorded significantly lower agronomic efficiency of nitrogen, phosphorus and potassium (30.84, 61.68 and 61.68 kg kg^{-1}, respectively). Drip irrigation scheduling at 125% PE up to tillering + 150% PE from tillering to PI + 200% PE from PI to physiological maturity recorded significantly higher agronomic efficiency of nitrogen, phosphorus and potassium in pooled data (41.25, 82.49 and 82.49 kg kg^{-1}, respectively) and identical trend in first (39.34, 78.68 and 78.68 kg kg^{-1}, respectively) and second season (43.15, 86.31 and 86.31 kg kg^{-1}, respectively). Significantly lower agronomic efficiency of nitrogen, phosphorus and potassium of aerobic rice were noticed in scheduling of drip irrigation at 100% PE up to tillering + 125% PE from tillering to PI + 150% PE from PI to physiological maturity (36.38, 72.75 and 72.75 kg kg^{-1}, respectively). Interaction between nutrient management × planting geometry × water management significantly influenced agronomic efficiency of nitrogen, phosphorus and potassium.

Application of 25% N & K from sowing to 30 DAS + 25% N & K from 31 to 50 DAS + 25% N & K from 51 to 80 DAS + 25% N & K from 81 to 105 DAS with planting geometry of 25×15 cm with drip irrigation scheduling at 125% PE up to tillering + 150% PE from tillering to PI + 200% PE from PI to physiological maturity recorded higher agronomic efficiency of nitrogen, phosphorus and potassium in pooled analysis (62.87, 125.74 and 125.74 kg kg^{-1}, respectively) first (60.47, 120.94 and 120.94 kg kg^{-1}, respectively) and second season (65.27, 130.54 and 130.54 kg kg^{-1}, respectively). However, lower agronomic efficiency of nitrogen, phosphorus and potassium were noted in control (15.31, 30.62 and 30.62 kg kg^{-1}, respectively) receiving soil application of fertilizers with drip irrigation (Table 1).

Higher agronomic efficiency of nitrogen, phosphorus and potassium under application of N and K in four equal splits up to 105 DAS, planting geometry of 25×15 cm and drip irrigation scheduling at 125% PE up to tillering + 150% PE from tillering to PI + 200% PE from PI to physiological maturity due to higher grain yield compared to other treatments. Drip fertigation scheduling at favourable moisture regimes in general registered higher nutrient use efficiency (N, P and K) as compared to direct soil application of nutrients. This was attributed to better availability of moisture and nutrients throughout crop growth stages in drip fertigation system leading to better uptake of nutrients, production of higher dry matter and in turn economical yield besides reduced loss of nutrients through leaching especially N and K. This indicated that required water availability in right amount at right time resulted in improved nutrient uptake with lesser losses. Such findings are in consonance with the findings of Raina *et al.,* (2011) in apricot and Anusha (2015) in drip irrigated aerobic rice. In these studies higher use efficiency of nutrients under fertigation might be ascribed to increased availability to the plants directly near the root zone. Lower nutrient use efficiency in soil application of fertilizers might be due to reduced nutrient uptake associated with reduced moisture availability and less solubility of nutrients. These results are in conformity with Gururaj (2013) and Anusha (2015).

Grain yield

The grain yield of aerobic rice was significantly influenced by precision management practices. Application of 25% N & K from sowing to 30 DAS + 25% N & K from 31 to 50 DAS + 25% N & K from 51 to 80 DAS + 25% N & K from 81 to 105 DAS recorded significantly higher grain yield in pooled analysis (7.36 t ha^{-1}) and identical trend in first (7.57 t ha^{-1}) and second season (7.15 t ha^{-1}). whereas, application of 50% N & K from sowing to 30 DAS + 25% N & K from 31 to 50 DAS + 25% N & K from 51 to 80 DAS recorded significantly lower grain yield (4.95 t ha^{-1}). Planting geometry of 25×15 cm recorded higher grain yield in pooled analysis (6.97 t ha^{-1}) and similar trend in first (7.17 t ha^{-1}) and second season (6.76 t ha^{-1}).

Significantly lower grain yield (5.36 t ha^{-1}) was registered in planting geometry of 25×25 cm in pooled analysis. Drip irrigation scheduling at 125% PE up to tillering + 150% PE from tillering to PI + 200% PE from PI to physiological maturity noticed higher grain yield in pooled analysis (6.40 t ha^{-1}) and identical trend was also followed in first (6.56 t ha^{-1}) and second season (6.23 t ha^{-1}). Whereas, lower grain yield (5.91 t ha^{-1}) was observed in scheduling of drip irrigation at 100% PE up to tillering + 125% PE from tillering to PI + 150% PE from PI to physiological maturity.

Interaction effect of nutrient management × planting geometry × water management found to be significant and the application of 25% N & K from sowing to 30 DAS + 25% N & K from 31 to 50 DAS + 25% N & K from 51 to 80 DAS + 25% N & K from 81 to 105 DAS with planting geometry of 25×15 cm with drip irrigation scheduling at 125% PE up to tillering + 150% PE from tillering to PI + 200% PE from PI to physiological maturity achieved higher grain yield in pooled analysis (8.56 t ha^{-1}) and the same trend in first (8.68 t ha^{-1}) and second (8.45 t ha^{-1}) season. Where, the lower grain yield (3.81 and 2.27 t ha^{-1}, respectively) was recorded in soil application of fertilizers with drip irrigation (control) and absolute control, respectively among all the precision management practices (Table 1).

The yield of aerobic rice differed significantly due to difference in growth attributes which were ultimately affected by time and levels of nutrients applied. Since the economic yield is a part of total biological yield of season, accumulation of total dry matter helps in enhancement of economical yield of a season.

Table.1 Agronomic efficiency (kg kg^{-1}) as influenced by precision management practices in drip irrigated aerobic rice

Treatments	Agronomic efficiency of nitrogen			Agronomic efficiency of phosphorus			Agronomic efficiency of potassium			Grain yield (t ha^{-1})		
	Summer 2016	*Kharif* 2016	Pooled	Summer 2016	*Kharif* 2016	Pooled	Summer 2016	*Kharif* 2016	Pooled	Summer 2016	*Kharif* 2016	Pooled
Nutrient management (N)												
N_1	25.08	28.46	26.77	50.17	56.93	53.55	50.17	56.93	53.55	5.14	4.76	4.95
N_2	49.40	52.30	50.85	98.80	104.60	101.70	98.80	104.60	101.70	7.57	7.15	7.36
S. Em. ±	0.79	1.80	1.02	1.57	3.60	2.04	1.57	3.60	2.04	0.08	0.18	0.09
C. D.@5%	2.28	5.23	2.88	4.57	10.46	5.77	4.57	10.46	5.77	0.22	0.51	0.24
Planting geometry (P)												
P_1	29.11	32.57	30.84	58.22	65.13	61.68	58.22	65.13	61.68	5.54	5.18	5.36
P_2	37.23	40.13	38.68	74.47	80.27	77.37	74.47	80.27	77.37	6.35	5.93	6.14
P_3	45.38	48.44	46.91	90.77	96.88	93.83	90.77	96.88	93.83	7.17	6.76	6.97
S. Em±	0.96	2.20	1.25	1.92	4.41	2.50	1.92	4.41	2.50	0.09	0.22	0.10
C. D.@5%	2.80	6.40	3.53	5.60	12.81	7.06	5.60	12.81	7.06	0.27	0.63	0.29
Water management (I)												
I_1	39.34	43.15	41.25	78.68	86.31	82.49	78.68	86.31	82.49	6.56	6.23	6.40
I_2	35.14	37.61	36.38	70.29	75.22	72.75	70.29	75.22	72.75	6.14	5.68	5.91
S. Em±	0.79	1.80	1.02	1.57	3.60	2.04	1.57	3.60	2.04	0.08	0.18	0.09
C. D.@5%	2.28	5.23	2.88	4.57	10.46	5.77	4.57	10.46	5.77	0.22	0.51	0.24
Nutrient management x planting geometry x water management (N x P x I)												
$N_1P_1I_1$	19.43	25.38	22.41	38.87	50.77	44.82	38.87	50.77	44.82	4.57	4.46	4.52
$N_1P_1I_2$	15.70	19.25	17.48	31.40	38.50	34.95	31.40	38.50	34.95	4.20	3.84	4.02
$N_1P_2I_1$	27.50	29.88	28.69	55.00	59.77	57.38	55.00	59.77	57.38	5.38	4.91	5.14
$N_1P_2I_2$	22.57	26.72	24.64	45.13	53.43	49.28	45.13	53.43	49.28	4.89	4.59	4.74
$N_1P_3I_1$	34.37	37.66	36.01	68.73	75.33	72.03	68.73	75.33	72.03	6.07	5.68	5.88
$N_1P_3I_2$	30.93	31.89	31.41	61.87	63.77	62.82	61.87	63.77	62.82	5.72	5.11	5.42
$N_2P_1I_1$	42.87	45.57	44.22	85.73	91.14	88.44	85.73	91.14	88.44	6.92	6.48	6.70
$N_2P_1I_2$	38.43	40.06	39.25	76.87	80.13	78.50	76.87	80.13	78.50	6.47	5.92	6.20
$N_2P_2I_1$	51.40	55.15	53.28	102.80	110.30	106.55	102.80	110.30	106.55	7.77	7.43	7.60
$N_2P_2I_2$	47.47	48.79	48.13	94.93	97.58	96.25	94.93	97.58	96.25	7.38	6.80	7.09
$N_2P_3I_1$	60.47	65.27	62.87	120.94	130.54	125.74	120.94	130.54	125.74	8.68	8.45	8.56
$N_2P_3I_2$	55.77	58.95	57.36	111.53	117.90	114.72	111.53	117.90	114.72	8.21	7.81	8.01
Control	12.90	17.72	15.31	25.80	35.43	30.62	25.80	35.43	30.62	3.92	3.69	3.81
Ab. control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.63	1.92	2.27
S. Em±	1.92	4.41	2.50	3.85	8.81	5.01	3.85	8.81	5.01	0.18	0.43	0.21
C. D.@5%	5.59	12.80	7.06	11.19	25.61	14.12	11.19	25.61	14.12	0.53	1.25	0.59

Note: CD-Critical difference, NS-Non significant

N_1: 50% N&K from sowing to 30 DAS +25% N&K from 31 to 50 DAS +25% N&K from 51 to 80 DAS, N_2:25% N&K from sowing to 30 DAS +25% N&K from 31 to 50 DAS +25% N&K from 51 to 80 DAS +25% N&K from 81 to 105 DAS, P_1: 25×25 cm, P_2: 25×20 cm, P_3: 25×15 cm, I_1: Drip irrigation at 125% PE up to tillering+150% PE from tillering to PI+200% PE from PI to physiological maturity, I_2: Drip irrigation at 100% PE up to tillering+125% PE from tillering to PI+150% PE from PI to physiological maturity, Control: (Drip irrigation at 150% PE throughout all growth stages and soil application of fertilizers), Ab. Control = Absolute Control: (No RDF with drip irrigation)

Table.2 Water used and water use efficiency as influenced by precision management practices in drip irrigated aerobic rice

Treatments	Water used (cm)			Water use efficiency (kg ha-cm^{-1})		
	Summer 2016	*Kharif* 2016	Pooled	Summer 2016	*Kharif* 2016	Pooled
T_1-$N_1P_1I_1$	128.15	104.50	116.32	35.7	42.7	38.8
T_2-$N_1P_1I_2$	107.00	83.84	95.42	39.3	45.8	42.2
T_3-$N_1P_2I_1$	128.15	104.50	116.32	42.0	47.0	44.2
T_4-$N_1P_2I_2$	107.00	83.84	95.42	45.7	54.7	49.7
T_5-$N_1P_3I_1$	128.15	104.50	116.32	47.3	54.4	50.5
T_6-$N_1P_3I_2$	107.00	83.84	95.42	53.5	60.9	56.7
T_7-$N_2P_1I_1$	128.15	104.50	116.32	54.0	62.0	57.6
T_8-$N_2P_1I_2$	107.00	83.84	95.42	60.5	70.7	65.0
T_9-$N_2P_2I_1$	128.15	104.50	116.32	60.6	71.1	65.4
T_{10}-$N_2P_2I_2$	107.00	83.84	95.42	68.9	81.1	74.3
T_{11}-$N_2P_3I_1$	128.15	104.50	116.32	67.7	80.8	73.6
T_{12}-$N_2P_3I_2$	107.00	83.84	95.42	76.7	93.2	83.9
T_{13}-Control	130.51	96.25	113.38	30.0	38.3	33.6
T_{14}-Absolute control	130.51	96.25	113.38	20.2	19.9	20.1

Note: CD-Critical difference, NS-Non significant

N_1: 50% N&K from sowing to 30 DAS +25% N&K from 31 to 50 DAS +25% N&K from 51 to 80 DAS, N_2:25% N&K from sowing to 30 DAS +25% N&K from 31 to 50 DAS +25% N&K from 51 to 80 DAS +25% N&K from 81 to 105 DAS, P_1: 25×25 cm, P_2: 25×20 cm, P_3: 25×15 cm, I_1: Drip irrigation at 125% PE up to tillering+150% PE from tillering to PI+200% PE from PI to physiological maturity, I_2: Drip irrigation at 100% PE up to tillering+125% PE from tillering to PI+150% PE from PI to physiological maturity, Control: (Drip irrigation at 150% PE throughout all growth stages and soil application of fertilizers), Ab. Control = Absolute Control: (No RDF with drip irrigation)

Table.3 Economics as influenced by precision management practices in drip irrigated aerobic rice

Treatments	Cost of cultivation (□ ha^{-1})			Gross returns (□ ha^{-1})			Net returns (□ ha^{-1})			B:C ratio		
	Summer 2016	*Kharif* 2016	Pooled	Summer 2016	*Kharif* 2016	Pooled	Summer 2016	*Kharif* 2016	Pooled	Summer 2016	*Kharif* 2016	Pooled
$N_1P_1I_1$	57473	54878	56175	74352	72374	73363	16879	17496	17188	1.29	1.32	1.31
$N_1P_1I_2$	57313	54718	56015	68313	62771	65542	11000	8053	9527	1.19	1.15	1.17
$N_1P_2I_1$	57491	54896	56193	87507	80215	83861	30016	25319	27668	1.52	1.46	1.49
$N_1P_2I_2$	57331	54736	56033	79482	74806	77144	22151	20070	21110	1.39	1.37	1.38
$N_1P_3I_1$	57525	54930	56227	98645	92664	95654	41120	37734	39427	1.71	1.69	1.70
$N_1P_3I_2$	57365	54770	56067	93059	83622	88340	35694	28852	32273	1.62	1.53	1.57
$N_2P_1I_1$	57473	54878	56175	112456	105534	108995	54983	50657	52820	1.96	1.92	1.94
$N_2P_1I_2$	57313	54718	56015	105172	96684	100928	47859	41966	44913	1.84	1.77	1.80
$N_2P_2I_1$	57491	54896	56193	126182	120764	123473	68691	65868	67280	2.19	2.20	2.20
$N_2P_2I_2$	57331	54736	56033	119822	110828	115325	62491	56093	59292	2.09	2.02	2.06
$N_2P_3I_1$	57525	54930	56227	140953	137207	139080	83428	82277	82853	2.45	2.50	2.47
$N_2P_3I_2$	57365	54770	56067	133306	127051	130179	75941	72282	74111	2.32	2.32	2.32
Control	51291	49938	50615	63738	60140	61939	12446	10201	11324	1.24	1.20	1.22
Ab. control	38915	38755	38835	42766	31618	37192	3851	-7137	-1643	1.10	0.82	0.96

N_1: 50% N&K from sowing to 30 DAS +25% N&K from 31 to 50 DAS +25% N&K from 51 to 80 DAS, N_2:25% N&K from sowing to 30 DAS +25% N&K from 31 to 50 DAS +25% N&K from 51 to 80 DAS +25% N&K from 81 to 105 DAS, P_1: 25×25 cm, P_2: 25×20 cm, P_3: 25×15 cm, I_1: Drip irrigation at 125% PE up to tillering+150% PE from tillering to PI+200% PE from PI to physiological maturity, I_2: Drip irrigation at 100% PE up to tillering+125% PE from tillering to PI+150% PE from PI to physiological maturity, Control: (Drip irrigation at 150% PE throughout all growth stages and soil application of fertilizers), Ab. Control = Absolute Control: (No RDF with drip irrigation)

Assessment of grain yield in different treatments indicated that significantly higher grain yield was observed with application of four equal splits of N and K up to 105 DAS which was attributed to higher leaf area and total number of tillers resulting in higher dry matter production compared to N and K in 3 splits up to 80 DAS. Thus could be attributed due to the minimum loss of N and K through leaching and efficient N-utilization by crop resulting in better vegetative growth and production of more filled spikelets, panicle weight and panicle length (Khavita and Balasubramanian, 2008). The straw and grain yields were significantly higher in 25 cm x 15 cm. This might be due to cumulative influence of higher plant population, more leaf area index, more of light interception and higher number of effective tillers per meter square and higher total dry matter per meter square, resulting in increased grain yield. Similar results were in accordance with Sultana *et al.,* (2012) and Ranjith (2015). Higher grain yield recorded with drip irrigation scheduling at 125% PE up to tillering + 150% PE from tillering to PI + 200% PE from PI to physiological maturity in aerobic rice may be due to its superiority in producing higher productive tillers hill^{-1}, panicle length, panicle weight, thousand grain weight and total number of grains panicle^{-1} with lower per cent chaffyness which is resulted in higher grain yield. The increase in the yield is related to higher leaf area index and crop growth rate which were contributed for assimilation of more photosynthates and resulted in superior yield attributes and yield. The similar type of results was also reported by Gururaj (2013). Due to frequent split application of fertilizers in drip irrigation coincided with the actual needs of season and favoured good growth, which resulted in maximum yield (Anusha, 2015). In this study also frequent application of fertilizers coincided with the nutrient demand and supplied more nutrients at peak time without any nutrient stress which might have resulted in higher grain yield than nutrients supplied through soil application.

Total water used and water use efficiency (WUE)

The variation was observed in total water used by aerobic rice due to drip irrigation scheduling based on open pan evaporation (Table 2). Aerobic rice with soil application of fertilizers and drip irrigation scheduling at 150% PE throughout all the growth stages used maximum water in first season (130.51 cm). Whereas, in second season (104.50 cm) and pooled analysis (116.32 cm) scheduling of drip irrigation at 125% PE up to tillering + 150% PE from tillering to PI + 200% PE from PI to physiological maturity used more water compared to scheduling of drip irrigation at 100% PE up to tillering + 125% PE from tillering to PI + 150% PE from PI to physiological maturity (107.0, 83.84 and 95.42 cm in first season, second season and pooled analysis, respectively). Water use efficiency (WUE) varied among precision management practices. Application of 25% N & K from sowing to 30 DAS + 25% N & K from 31 to 50 DAS + 25% N & K from 51 to 80 DAS + 25% N & K from 81 to 105 DAS with planting geometry of 25×15 cm with drip irrigation scheduling at 100% PE up to tillering + 125% PE from tillering to PI + 150% PE from PI to physiological maturity recorded higher WUE (83.9 kg ha-cm^{-1}) and similar trend in first (76.7 kg ha-cm^{-1}) and second season (93.2 kg ha-cm^{-1}). Lower WUE (33.6 kg ha-cm^{-1} in pooled analysis) was noticed in drip irrigation with soil application of fertilizers (control) and absolute control (20.1 kg ha-cm^{-1} in pooled analysis).

Increase in water use efficiency was attributed to increased grain yield with decreased water consumption as compared to drip irrigation scheduling at 150% PE throughout the growth stages. In the present investigation, 150% PE throughout the growth stages with soil application of fertilizers consumed higher amount of water (116.32 cm) with significantly lower yield which resulted in lower water use efficiency which might be due to increased leaching and volatilization losses of nitrogen. The increase in water use efficiency in all drip fertigated treatments over soil application of fertilizers was mainly due to considerable saving of water and nutrients, greater increase in yield of crop and higher nutrient use efficiency as a result of timely, sufficiently and frequent supplementation of water and nutrient to root zone leading to the decrease in leaching and volatilization losses of nitrogen.. This was in accordance with Gururaj (2013) and Anusha (2015) in rice. These studies reveal that supplying water to soil and nearer to the plant with sufficient quantities resulting in higher water use efficiency.

Economics

The economics of aerobic rice cultivation differed due to precision management practices with respect to gross return, which was a result of prices and yield of marketable produce, cost of cultivation which varied in relation to different inputs used, and in turn net returns and B: C ratio (Table 3). Pooled data indicated that, higher gross return, net return and B:C ratio was recorded (□ 1,39,080 ha^{-1}, □ 82,853 ha^{-1} and 2.47, respectively) in application of 25% N & K from sowing to 30 DAS + 25% N & K from 31 to 50 DAS + 25% N & K from 51 to 80 DAS + 25% N & K from 81 to 105 DAS with planting geometry of 25×15 cm with drip irrigation scheduling at 125% PE up to tillering + 150% PE from tillering to PI + 200% PE from PI to physiological maturity. Lower gross return, negative net return and B: C ratio was recorded by absolute control (□ 37,192 ha^{-1} □ -1,643 ha^{-1} and 0.96, respectively) in pooled data. This was mainly due to reduced grain and straw yield and increased cost of cultivation.

In conclusion, Precision management practices in combination of 25×15 cm planting geometry and drip irrigation scheduling at 125 % PE up to tillering + 150% PE from tillering to PI + 200% PE from PI to physiological maturity along with application of N and K in four splits up to 105 DAS through drip fertigation was the best precision management practice for achieving higher grain yield, net returns and B: C ratio.

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References

Anusha, S., Nagaraju, Shankaralingappa, B.C., Sheshadri, T., Channabasavegowda, R., Shankar, A.G. and Mallikarjuna, G.B. 2015. Influence of fertigation intervals and fertilizer combinations on growth and yield of direct seeded drip irrigated aerobic rice. *The Ecoscan*, 9(1&2): 299-303.

Bouman, B.A.M., Humphreys, E., Tuong, T.P. and Barker, R. 2007. Rice and water. *Adv. Agron*., 92: 187-237.

Cantrell, R.P. and Teeves, T.G. 2002. The cereal of the world’s poor takes centre stage. *Science*, 296: 53.

Crookston, K. 2006. A top 10 list of developments and issues impacting crop management and ecology during the past 50 years. *Crop Sci.* 46, 2253-2262.

Gururaj, K. 2013. Optimization of water and nutrient requirement through drip fertigation in aerobic rice. *M.Sc. (Agri.)*

Thesis, Univ. of Agril. Sci., Bengaluru.

Hedley, C.B. and Yule, I.J. 2009. Soil water status mapping and two variable-rate irrigation scenarios. *Precis. Agric*., 10: 342-355.

Khavita, M.P. and Balasubramanian, R. 2008. Maximizing hybrid rice productivity through nitrogen and potassium. *Crop Res.*, 35(3): 169-171.

Laborte, A.G., de Bie, K., Smaling, E.M.A., Moya, P.F., Boling, A.A. and van Ittersum, M.K. 2012. Rice yields and yield gaps in South East Asia: past trends and future outlook. *Eur. J. Agron*., 36: 9-20.

Mahlein, A., Oerke, E., Steiner, U. and Dehne, H. 2012. Recent advances in sensing plant diseases for precision crop protection. *Eur. J. Plant Pathol*, 133: 197-209.

Miao, Y., Mulla, D.J. and Robert, P.C. 2006. Spatial variability of soil properties, corn quality and yield in two Illinois, USA fields: implications for precision corn management. *Precis. Agric.* 7: 5-20.

Mueller, N.D., Gerber, J.S., Johnston, M., Ray, D.K., Ramankutty, N. and Foley, J.A. 2012. Closing yield gaps through nutrient and water management. *Nature*, 490: 254-257.

Normile, D. 2008. Reinventing rice to feed the world. *Science*, 321: 330-333.

Peng, S., Buresh, R.J., Huang, J., Zhong, X., Zou, Y., Yang, J., Wang, G., Liu, Y., Hu, R., Tang, Q., Cui, K., Zhang, F. and Dobermann, A. 2010. Improving nitrogen fertilization in rice by site-specific N management. A review. *Agron. Sustain. Dev*., 30: 649-656.

Raina, J.N., Sharma, T. and Suman, S. 2011. Effect of drip fertigation with different fertilizers on nutrient distribution in soil, leaf nutrient content and yield of apricot (*Prunus aremeniaca* L.). *J. Indian Soc. Soil Sci.*, 59: 268-277.

Ranjith, T.M. 2015. Standardisation of planting geometry in aerobic rice (*Oryza sativa L*.) under different levels of drip fertigation. *M.Sc (Agri.) Thesis*, Univ. of Agril. Sci., Bengaluru.

Shen, J., Cui, Z., Miao, Y., Mi, G., Zhang, H., Fan, M., Zhang, C., Jiang, R., Zhang, W., Li, H., Chen, X., Li, X. and Zhang, F. 2013. Transforming agriculture in China: from solely high yield to both high yield and high resource use efficiency. *Global Food Security*, 2: 1-8.

Sultana, M.R., Rahman, M.M. and Rahman, M.H. 2012. Effect of row and hill spacing on the yield performance of boro rice (cv. BRRI dhan45) under aerobic system of cultivation. *J. Bangladesh Agril. Univ.,* 10(1): 39-42.

Tilman, D., Balzer, C., Hill, J. and Befort, B.L. 2011. Global food demand and the sustainable intensification of agriculture. *Proc. Natl. Acad. Sci. U.S.A.* 108, 20260–20264.

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