

Original Research Article

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Productivity and Profitability of Direct Seeded Early *Ahu* Rice under Medium Land Situation

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ABSTRACT

A field experiment was carried out at the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during 2017 to develop the irrigation schedule of direct seeded early *Ahu* rice under medium land situation and to find out the suitable nutrient management practices for direct seeded early *Ahu* rice to suit the variability in rainfall pattern. The treatments consisted of four irrigation regimes *viz.* irrigation at 80% available water till onset of pre-monsoon rain (I₁), irrigation at 70% available water till onset of pre-monsoon rain (I₂), irrigation at 60% available water till onset of pre-monsoon rain (I₃) and rainfed (I₄) as main plot and three nutrient management treatments *viz.* full P as basal + ½ N and ½ K at 20 days after sowing (DAS) + ½ N and ½ K at 40 DAS (N₁), full P as basal, 1/3 N and 1/3 K as basal + 1/3 N and 1/3 K at 20 DAS + 1/3 N and 1/3 K at 40 DAS (N₂) and full P as basal, ½ N and ½ K as basal + ¼ N and ¼ K at 20 DAS + ¼ N and ¼ K at 40 DAS (N₃) as sub plot and control (transplanted early *Ahu* rice with recommended water and fertilizer management practices). Experimental findings revealed that irrigation at 80% available water till onset of pre monsoon rain (I₁) recorded the highest values for all the morphological and physiological parameters along with the yield and yield attributing characters of the crop. The highest grain yield (39.83 q/ha) and straw yield (90.96 q/ha) were recorded at irrigation at 80% available water (I₁). Among the nutrient management practices, the highest values of all the morphological and physiological parameters along with the yield and yield attributing characters of the crop were recorded under full P as basal + ½ N and ½ K at 20 DAS + ½ N and ½ K at 40 DAS (N₁). This treatment also recorded the highest grain yield (34.16 q/ha) and straw yield (83.45 q/ha). The experiment did not show any significant difference between direct seeded crop and transplanted crop with respect to growth parameters, yield attributes and yield. Direct seeded crop recorded the higher net return and benefit-cost ratio over the transplanted rice.

Keywords

Direct seeded rice,
Early *Ahu*, Irrigation,
Nutrient
management

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Introduction

Rice is a staple crop for nearly half of the world's seven billion people (Mohanty, 2013). It is a staple food of Assamese of all ages, influencing the cropping pattern of the state (Talukdar and Deka, 2005). The crop occupies about two-third of the gross cropped area of the state. Three rice crops are grown in a year *i.e.* autumn, winter and summer. Direct seeded early *ahu* rice is grown under rainfed condition while transplanted early *ahu* rice is grown with irrigation facilities. There are three principal methods of direct seeded rice (DSR) *viz.* dry seeding (sowing dry seeds into dry soil), wet seeding (sowing pre-germinated seeds in wet puddled soil) and water seeding (seeds sown into standing water). Dry seeding has been the principal method of establishment (Akhgari and Kaviani, 2011).

The rice cultivation system is affected by water deficient, less suitable land and shortages of labourer (Nguyen and Ferrero, 2006). Direct seeded rice is a major opportunity to change production practices to attain optimal plant density and high water productivity in water scarce areas. Adoption of direct seeded rice for lowland rice culture would significantly decrease costs of rice production (Flinn and Mandac, 1986). Dry seeding reduces the overall water demand of rice by reducing water needed for land preparation, losses due to evaporation, leaching, percolation etc. (Bouman and Tuong, 2001). Direct seeded rice (DSR) is a technology which does not require any specialized farm implements and it can be sown using the same seed drill in more or less same manner as other crops such as wheat. Labour use on a DSR plot is about 50% less than on non DSR plots. In the face of increasing population and growing demand for food the upgrading of rainfed areas through DSR technology can help in soil and

water conservation and deal with risks arising from climate change. With this ideas in mind, this investigation was planned to develop the irrigation schedule and to find out the suitable nutrient management practices of direct seeded early *ahu* rice under medium land situation to suit the variability in rainfall pattern.

Materials and Methods

The present experiment was conducted to study the effect of direct seeding on productivity and profitability of early *ahu* rice on the basis of direct seeded rice production technology under medium land situation. The field experiment was conducted during the *ahu* season at Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat-13. The ICR Farm is situated at 26°47' N latitude, 94°12' E longitude and at an altitude of 87.0 meter above mean sea level. The climatic condition of Jorhat is sub-tropical humid with hot summer and cold winter. Normally, monsoon starts from the month of June and continues up to the month of September with the occurrence of low pre-monsoon showers from mid March. The intensity of rainfall decreases from the month of October and reaches minimum during December-January. During the entire period of investigation, the total amount of rainfall received was 768.0 mm with a maximum average weekly rainfall of 115.9 mm on 26th March to 1st April, 2017. The weekly mean maximum temperature ranged from 26.6°C to 14.9°C and weekly mean minimum temperature ranged from 26.1°C to 14.4°C. The weekly average relative humidity ranged from 96.6 per cent to 90.4 per cent during the morning hours and 82.1 per cent to 44.3 per cent in the evening hours. The highest weekly bright sunshine hours was recorded in the month of April (7.4 hours/day) and lowest in the month of June (1.6 hours/day). The weekly mean evaporation varied from

2.1mm/day to 4.2 mm/day during the study period. The soil of the experimental plot was silt loam in texture, acidic in reaction having pH 5.2, organic carbon 7.2 g/kg, alkaline KMnO₄ extractable N 181.0 kg/ha, Brays-I P 10.7 kg/ha and 1 N ammonium acetate extractable K 227.9 kg/ha. It contained soil moisture 27.6% at -0.03 MPa and 9.6 % at -1.5 MPa with bulk density of 1.34 g/cc. The rice variety “Inglongkiri” was sown on 18th February, 2017. The control treatment with recommended water and nutrient management practice was transplanted on 17th March, 2017.

The experiment was laid out in split plot design with 3 replications and 13 treatments. The main plot treatment included irrigation schedule *viz.* I₁: Irrigation at 80% available water till onset of pre-monsoon rain, I₂: Irrigation at 70% available water till onset of pre-monsoon rain, I₃: Irrigation at 60% available water till onset of pre-monsoon rain and I₄: rainfed. The subplot treatment included nutrient management *viz.* N₁: Full P as basal + ½ N & ½ K at 20 DAS + ½ N & ½ K at 40 DAS, N₂: Full P as basal & 1/3 N & 1/3 K as basal + 1/3 N & 1/3 K at 20 DAS + 1/3 N & 1/3 K at 40 DAS, N₃: Full P as basal and ½ N and ½ K as basal + ¼ N and ¼ K at 20 DAS + ¼ N and ¼ K at 40 DAS A control treatment *i.e.* transplanted early *ahu* rice with recommended water and fertilizer management practices was included. Recommended dose of fertilizer @ 40-20-20 as N-P₂O₅-K₂O kg/ha was applied in the form of urea, SSP and MOP. Fertilizers were applied as per treatment. In control plot, full P₂O₅ and K₂O and half N were applied as basal. One fourth N was applied at maximum tillering and one fourth N was applied at panicle initiation stage. The sowing was done manually by line sowing with seed rate 75 kg/ha. On the same day, seeds were soaked to sow in nursery bed for transplanting in control plot with seed rate 45 kg/ha. Seedlings were

transplanted on 17th March, 2017 by maintaining a spacing of 20 cm × 15 cm in the control plot. Two weedings were done at 3 weeks and 6 weeks after sowing by manual hoeing to reduce the ill effect of weeds which makes the environment unfavorable for growth of rice. In transplanted crop, Japanese Paddy Weeder was operated after top dressing of urea to incorporate the fertilizer as well as to control the weeds. Irrigation was applied as per treatment. In each plot, 5 cm irrigation water was applied when water level depleted to a certain level as per treatment. Then the grain and straw yields were measured separately in kg per plot and converted to kg per ha (at 14% moisture content in grain).

The data were analyzed statistically and the mean differences among the treatment means were evaluated by the least significance difference (LSD) at 5% level of probability (Sarma, 2016). For economic analysis, all input costs including the cost for lease of land and interest on running capital were considered for computing the cost of production. The benefit-cost ratio was computed by dividing gross return by total cost of cultivation.

Results and Discussion

Growth characters

The morphological characteristics of the plant like number dry matter accumulation, Crop Growth Rate (CGR), and Leaf Area Index (LAI) showed marked differences under various irrigation and nutrient management management practices (Table 1 and Fig. 1, 2 & 3). Significantly the highest dry matter accumulation at 60 DAS and at harvest was obtained with irrigation at 80% available water till onset of pre-monsoon rain (I₁). This treatment also recorded the highest Leaf Area Index (LAI), however it was at par with irrigation at 70% available water till onset of

pre-monsoon rain (I_2) at 60 DAS. Growth in terms of crop growth rate (CGR) was observed to be improved with irrigation at 80% available water (I_1) which might be ascribed to increased photosynthetic surface and biomass accumulation by the crop (Yoshida *et al.*, 1981). In the present study, better growth parameters under this treatment could be due to the maintenance of soil moisture at or near field capacity. On the other hand, when irrigation was applied at 30% (I_2) and 40% (I_3) depletion of available water, it resulted in more drying period and evaporative demand of the crop was not adequately fulfilled. The rainfed crop suffered from moisture stress as the crop received the first rainfall (9.8 mm) at 18 DAS. Up to 29 DAS, the crop did not received sufficient rainfall which could meet the crop water demand. Thus, growth parameters under these treatments were relatively lower than irrigation applied at 80% available water. Soil drying not only limits root water uptake which can (but not always) perturb shoot water status, but also alters synthesis of phytohormones by root and their transport to shoots to regulate leaf growth and gas exchange. Re-wetting the soil rapidly restores leaf water potential and leaf growth (minutes to hours), but gas exchange recovers more slowly (hours to days), probably mediated by sustained changes in root to shoot phytohormonal signaling (Dodd *et al.*, 2015). The increased growth parameters in irrigation at 80% available water (I_1) might be due to higher moisture availability which favoured development of plant infrastructure. Rainfed crop could not compete with the irrigated treatments due to reduction in soil moisture content much below the field capacity. These findings are in harmony with those reported by Shekara *et al.*, (2010) and Dass and Dhar (2014).

The effect of different nutrient management practices on morphological parameters

barring plant height was found to be statistically significant for all the growth stages. Application of full P as basal + $\frac{1}{2}$ N and $\frac{1}{2}$ K at 20 DAS + $\frac{1}{2}$ N and $\frac{1}{2}$ K at 40 DAS (N_1) being at par with full P as basal & $\frac{1}{3}$ N & $\frac{1}{3}$ K as basal + $\frac{1}{3}$ N & $\frac{1}{3}$ K at 20 DAS + $\frac{1}{3}$ N & $\frac{1}{3}$ K at 40 DAS recorded the highest dry matter accumulation and LAI at 60 DAS and at harvest. This might be due to the split application of nitrogen and potassium at right time with greater synchrony between crop demand and nutrient supply. Yoshida *et al.*, (1981) also reported that nitrogen should be supplied at about 20 days before heading, if it is very limited. When the supply is moderate, nitrogen may be given twice *viz.* at the early growth stages and at about 20 days before heading. When nitrogen is abundant, application of N at early growth stages are most efficient for grain production. Applying nitrogen at about 20 days before heading has a high productive efficiency when the level is moderate or low. This period coincides with the active growth of young panicles before heading. The absorbed nitrogen at this time is efficiently used to increase spikelet number and hence, panicle size. For this reason, topdressing at panicle initiation is called Hogo in Japanese, implying panicle fertilizer. For soils with low nitrogen-holding capacity, split applications of fertilizer resulted in a higher nitrogen recovery and, hence, a higher yield than a basal application.

Yield attributes and yield

The significant variation in growth characteristics as a result of differential application of irrigation and nutrient management further led to marked variation in yield attributes of rice crop. In the present study, rice crop with irrigation at 80% available water (I_1) produced higher yield attributes than that with the crop irrigation at 70% and 60% available water (I_2 and I_3) and without irrigation (I_4) (Table 2). It could be

inferred from results of present investigation that irrigation to direct seeded crop at 80% available water (I₁) involving three irrigations at 12, 23 and 34 DAS maintained favourable soil moisture condition for better growth and development and partitioning of photosynthates and dry matter to seed. The highest grain yield and straw yield being 39.83 and 90.96 q/ha, respectively was recorded from irrigation at 80% available water (I₁). This treatment produced 14.7, 25.7 and 36.7 per cent higher yield than irrigation at 70% and 60% available water (I₂ and I₃) and rainfed crop (I₄). Higher seed yield under irrigation at 80% available water might be attributed to the higher values of various yield components under the treatment. The

decrease in grain and straw yield in other treatments was due to the decreased soil water content as a result of differential irrigation schedules. There was a consistent trend of decline in grain and straw yield as the irrigation threshold increased. Lower yield of direct seeded rice under greater water deficit might be due to lower number of grains/panicle and lower effective tillers/m². Similar results were reported by McDonald *et al.*, (2005), Kukal *et al.*, (2010) and Naresh *et al.*, (2013). In the present study, yield of direct seeded rice was at par with transplanted rice. Kabat (2012) also reported that rice growth and yield were statistically similar under direct seeding and transplanting conditions.

Table.1 Effect of irrigation schedule and nutrient management on plant height, dry matter and leaf area index of rice

Treatments	Plant height at harvest		Dry matter m ⁻²		Leaf Area Index	
	At 60 DAS	At harvest	At 60 DAS	At harvest	At 60 DAS	At harvest
Irrigation Schedule (I)						
I ₁	45.8	141.6	597.0	1310.4	4.9	2.5
I ₂	45.3	137.1	527.0	1173.9	4.4	2.2
I ₃	44.8	135.8	516.9	1086.9	3.7	1.5
I ₄	44.1	134.9	501.8	1038.2	2.0	1.1
SEm ±	1.7	4.6	17.9	40.0	0.1	0.1
CD _{0.05}	NS	NS	58.2	130.4	0.5	0.2
Nutrient Management (N)						
N ₁	45.7	139.4	570.1	1241.6	4.8	2.4
N ₂	45.6	136.7	540.1	1141.9	4.5	2.3
N ₃	43.8	135.9	496.8	1073.8	2.1	0.8
SEm ±	1.4	3.9	12.4	34.4	0.1	0.1
CD _{0.05}	NS	NS	37.3	103.1	0.3	0.15
Interaction (I×N)	NS	NS	NS	NS	NS	NS
Control vs treatment						
Treatment	45.0	137.4	535.7	1152.4	3.8	1.8
Control	39.8	135.3	548.4	1183.3	4.0	1.9
SEm±	3.1	8.3	32.2	72.1	0.27	0.12
CD (P = 0.05)	NS	NS	NS	NS	NS	NS

Table.2 Effect of irrigation schedule and nutrient management on yield attributes and grain and straw yield of rice

Treatments	Effective tillers/m ²	No. of grains /panicle	1000 seed weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index	Net Return (₹)	B:C ratio
Irrigation Schedule (I)								
I ₁	186.1	97.3	24.1	39.83	90.96	30.5	34937.17	2.20
I ₂	165.6	95.3	24.1	34.72	79.90	30.3	27369.00	1.96
I ₃	154.1	90.0	24.1	31.68	74.30	29.9	22989.00	1.82
I ₄	142.3	86.5	24.0	29.14	72.30	28.7	19589.17	1.71
SEm ±	5.8	2.8	0.5	1.30	2.99	0.9	-	-
CD _{0.05}	18.8	9.3	NS	4.24	9.74	NS	-	-
Nutrient management (N)								
N ₁	173.8	98.2	24.1	37.16	83.45	30.8	31483.75	2.11
N ₂	163.1	92.6	24.1	33.54	79.36	29.7	26153.13	1.92
N ₃	149.2	86.1	24.0	30.83	75.30	29.0	21026.38	1.74
SEm ±	4.1	2.0	0.5	1.08	2.54	0.80	-	-
SEm ±	12.2	6.10	NS	3.24	7.61	NS	-	-
CD _{0.05}	NS	NS	NS	NS	NS	NS	-	-
Interaction (I×N)	NS	NS	NS	NS	NS	NS	-	-
Control vs treatment								
Treatment	162.0	92.3	24.1	33.84	79.37	29.9	31483.75	2.11
Control	166.3	96.6	24.1	37.04	81.53	31.2	19212.10	1.48
SEm±	10.42	5.13	0.97	2.34	5.39	1.69	-	-
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	-	-

Fig.1 Effect of irrigation schedule on Crop Growth Rate (CGR) at different growth stages of rice

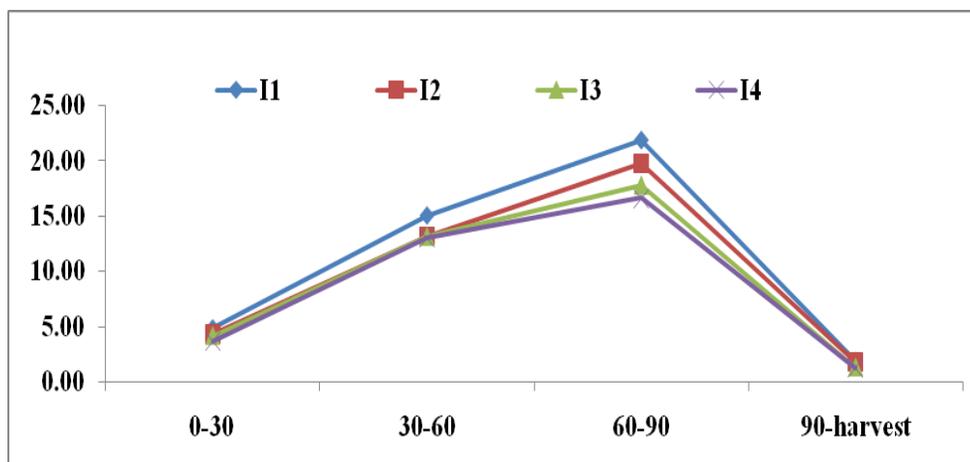


Fig.2 Effect of nutrient management on Crop Growth Rate (CGR) at different growth stages of rice

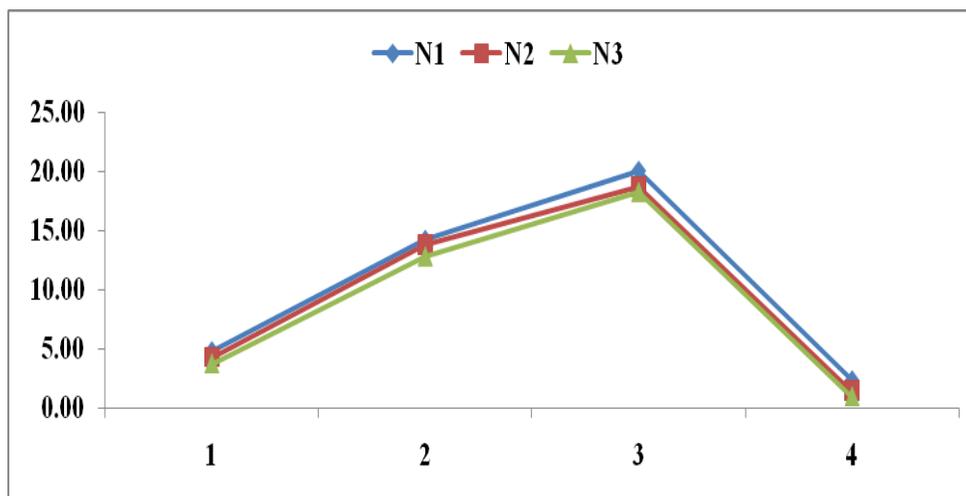
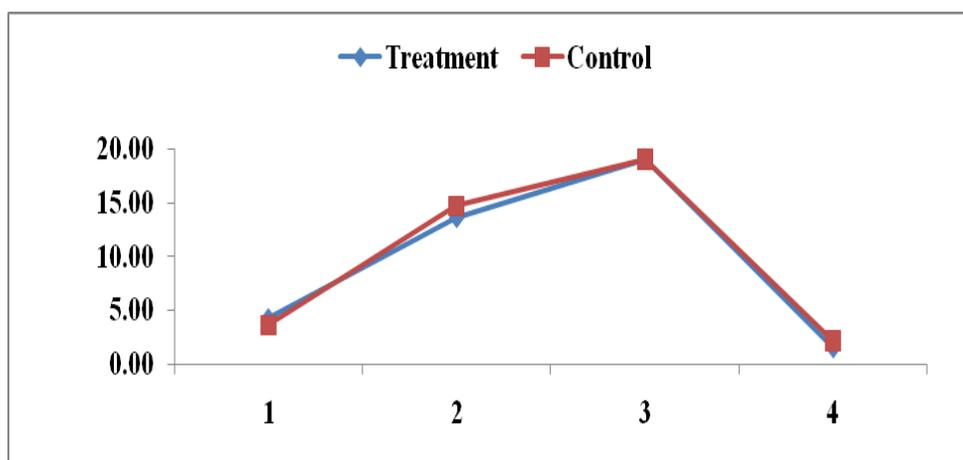


Fig.3 Crop Growth Rate (CGR) at different growth stages of rice (Control vs treatment)



The seed and stover yield increased significantly with two splits of N and K at 20 and 40 DAS (N_1) than 3 splits (N_2 and N_3). Two splits of N and K at 20 and 40 DAS (N_1) recorded higher yield attributing characters of direct seeded rice than 3 splits (N_2 and N_3). The effective response to N and K application sets in when level of N and K satisfies the hunger in soil and the soil expected to behave. In the present experiment, two splits of N and K satiated the soil hunger more than 3 splits. Similar results were reported by Ravichandran (2011).

Economics

The irrigation at 80% available water (I_1) recorded the highest net return (₹34937.17) and benefit-cost ratio (2.20). This is due to higher crop yield and relatively less production cost. On the other hand transplanted crop recorded the lowest net return (₹19212.1) and benefit-cost ratio (1.48) due to higher cost of production. The major determinant of cost of production is labour, water and fertilizers in rice cultivation. Omission of puddling saved considerable

labour and water costs. Sahrawat *et al.*, (2009) also observed 13-16% labour savings in direct seeded rice systems. Among the nutrient management treatments, full P as basal + ½ N and ½ K at 20 DAS + ½ N and ½ K at 40 DAS (N₁) recorded the highest net return (₹ 31483.75) and benefit-cost ratio (2.11) due to higher crop yield with same level of production cost. Collateral findings have been reported by Kumar *et al.*, (2009).

Thus, under medium land situation, there is possibility of growing rice by direct seeding instead of transplanting. Under direct seeded condition, crop should be irrigated at 80% available water till onset of pre monsoon rain. Entire recommended dose of P₂O₅ (20 kg/ha) should be applied as basal. Half of the recommended dose of N (10 kg/ha) and K₂O (10 kg/ha) should be top dressed at 20 days after sowing. Rest half of the recommended N (10 kg/ha) and K₂O (10 kg/ha) should be top dressed at 40 days after sowing.

References

- Akhgari, H. and Kaviani, B. (2011). Assessment of direct seeded and transplanting method of rice cultivars in the northern part of Iran. *African Journal of Agricultural Research* 6(31): 6492-6498.
- Bouman, B.A.M. and Tuong, T.P. (2001). Field water management to save water and increase its productivity in irrigated lowland rice. *Agricultural Water Management* 49: 11-30.
- Dass, A. and Dhar, S. (2014). Irrigation management for improving productivity, nutrient uptake and water-use efficiency in system of rice intensification: a review. *Annals of Agricultural Research* 35(2): 107-122.
- Dodd, I.C., Puertolas, J., Huber, K., Perez-Perez, J.G., Wright, H.R. and Blackwell, M.S.A. (2015). The importance of soil drying and re-wetting in crop phytohormonal and nutritional responses to deficit irrigation. *Journal of Experimental Botany* 66(8): 2239-2252.
- Flinn, J.C. and Mandac, A.M. (1986). Wet seeding of rice in less favored rainfed environments. In: Working paper, Agricultural Economics Department, International Rice Research Institute, Los Banos, Philippines.
- Kabat, S. (2012). Influence of farm yard manure, brown manuring and levels of nitrogen on yield and quality parameters of direct seeded and transplanted rice. *Oryza*. 49(3): 231-233.
- Kukul, S.S., Yadav, S., Humphrey, E., Kaura, A., Singh, Y., Thaman, S., Singh, B. and Timsina, J. (2010). Factors affecting irrigation water savings in raised beds in rice and wheat. *Field Crops Research* 118: 43-50.
- Kumar, V., Ladha, J.K. and Gathala, M.K. (2009). Direct drill-seeded rice: A need of the day. Annual Meeting of Agronomy Society of America, Pittsburgh, November 1-5, 2009 (http://a-cs.confex.com/crops/2009am/webprogram/Paper_53386.html).
- McDonald, A.J., Riha, S.J., Duxbury, J.M. and Steenhuis, T.S. (2005). Water balance and rice growth responses to direct seeding, deep tillage and landscape placement : Findings from a valley terrain in Nepal. *Field Crops Research* 95: 367-382.
- Mohanty, S. (2013). Trends in global rice production. *Rice Today* 12(1): 44-45.
- Naresh, R.K., Mishra, A.K. and Singh, S.P. (2013). Assessment of direct seeded and transplanting method of rice cultivars in the western part of Uttar Pradesh. *International Journal of Pharmaceutical Sciences and Business*

- Management* 1(1): 1-8.
- Nguyen, N.V. and Ferrero, A. (2006). Meeting the challenges of global rice production. *Paddy Water Environment* 4: 1-9.
- Ravichandran, M. (2011). Optimizing timing and potassium application in productivity enhancement of crops. *Karnataka Journal of Agricultural Sciences* 24 (1): 75-80.
- Shekara, B.G., Sharnappa, K. and Krishnamurthy, N. (2010). Effect of irrigation schedules on growth and yield of aerobic rice (*Oryza sativa* L.) under varied levels of farmyard manure in Cauvery command area. *Indian Journal of Agronomy* 55(1): 35-39.
- Talukdar, K.C. and Deka, B.C. (2005). Cultivation of summer rice in the flood plains of Assam - an assessment of economic potential on marginal and small farms. *Agricultural Economics Research Review* 18: 21-38.
- Yoshida, S., Satake, T. and Mackill, D. (1981). High-temperature stress in rice. *IRRI Research Paper Series* 67: 1-15.

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