

Nursery Management Options for Enhancing Post Flood Survival, Productivity and Economics of Rice (*Oryza sativa* L.) under Submergence in West Central Table Land Zone of Odisha

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(Received 05 October 2021, Accepted 09 December, 2021)

(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: A field experiment was conducted at the Instructional Farm of the College of Agriculture, Chiplima, Sambalpur, Odisha *kharif* seasons in the year 2019 where submergence tolerant rice (Cultivar 'Swarna sub 1') was taken as test crop to investigate the effect of nursery management on seedling vigour and post flood survival of rice (*Oryza sativa* L.) as well as to study its subsequent effect on yield and economics under submergence. As Post flood survival and subsequent plant establishment are major challenges in flood prone areas, which many often depend upon the seedling vigour at the time of transplanting. Application of fertilizers and sowing of the pre germinated seeds were done as per the treatments. The Main field lay out was done as per the nursery lay out. A common Fertilizer dose of N:P₂O₅:K₂O at 80:40:40 kg ha⁻¹ was applied in the main field. Plants were completely submerged at 10 DAT with a water depth of 1.1 meter for a period of 15 days. From the experimental findings it revealed that application of N:P₂O₅:K₂O at 100:40:40 kg ha⁻¹ in the rice nursery produced the highest dry matter production plant⁻¹, seedling length and leaf area seedling⁻¹ at transplanting in nursery and was comparable with application of N:P₂O₅:K₂O at 80:40:40 kg ha⁻¹ (25 kg N ha⁻¹ from FYM at 5 t ha⁻¹). The lower seeding density of 40 g m⁻² and seedlings of 40 days old registered significantly higher dry matter production, seedling length and leaf area seedling⁻¹ in nursery than the higher seeding density of 60 g m⁻² and seedlings of 30 days old respectively. The highest survival of plants after de submergence in the main field was recorded with application of N:P₂O₅:K₂O at 80:40:40 kg ha⁻¹ (25 kg N ha⁻¹ from FYM at 5 t ha⁻¹) which was significantly higher than all other nutrient treatments. The lower seeding density of 40 g m⁻² and seedlings of 40 days registered significantly higher post flood survival % than the higher seeding density of 60 g m⁻² and seedlings of 30 days old, respectively. Application of N:P₂O₅:K₂O at 80:40:40 kg ha⁻¹ (N₂) in the main plot treatment of rice nursery treatment also recorded significantly higher grain yield & straw yield than all other nutrient treatments. The lower seeding density of 40 g m⁻² (D₁) in the nursery and older seedlings of 40 days recorded significantly higher grain yield and straw yield than higher seeding density of 60 g m⁻² (D₂) in the nursery and younger seedlings of 30 days, respectively. Such practices significantly increased the post flood survival of rice leading to record significantly higher growth parameters and return rupees⁻¹ invested of rice in flood prone low land condition. Application of N:P₂O₅:K₂O at 80:40:40 kg ha⁻¹ (25 kg of N applied through FYM at 5 t ha⁻¹), seeding density of 40 g m⁻² and transplanting of 40 days old seedlings appeared to be the most promising and remunerative nursery management practice of rice under submergence condition for the West central table land zone of Odisha.

Keywords: Rice, Submergence, Nursery management, Nutrient management, Age of seedling, Seeding density.

INTRODUCTION

Rice plays a vital role in India's agrarian economy as it is the source of livelihood for a millions of rural households as well as it plays an important role in food security of the nation. World's rice demand is projected to increase by 38% from the year 2001 to 2025-2030 which is to be produced to keep pace with population growth with less land, water, labor and chemical inputs (Khush, 1997) as well as under different biotic and abiotic stresses. The rice crop in India is currently grown in about 43.4 m ha, with the production of 157.2 m t and productivity of 3.62 t ha⁻¹ (FAO, 2016). The rain-fed low land rice occupying a major portion of total rice area has a significant role in total rice production of India. However, rice grown in these areas is very often subjected to partial or complete submergence for a period of one to two week at different stages of growth leading to poor yield of rice. About 13 m ha of rice land prone to floods, partial to complete submergence every year are present in eastern India including Odisha (Ram *et al.*, 2009; Bishoyi *et al.*, 2017). Odisha is one of the eastern states occupying 4.7% of total geographical area of country and about 10.2% of total rice area of the country. About 36% of the rice growing area in this state comes under the purview of rain-fed low lands, which suffer from frequent flash floods due to erratic behavior of the monsoon during *kharif* season causing drastic crop yield reduction. In Odisha rice is grown in an area of 4.5 m ha, out of which around 1, 21, 000 ha rice area is flood prone (Singh *et al.*, 2004). Flash flood or submergence is a common phenomenon in these low land areas seriously affecting crop establishment as well as survival leading to severe yield losses. It imposes a complex abiotic stress in flood prone ecosystem, because it substantially reduces crop stand, especially if it occurs during early vegetative stage and prolongs for more than a week (Bailey-Serres *et al.*, 2010). However, these flood prone ecosystems have enormous potential for higher food production to meet the ever increasing demands for rice supply because of predominance of good soils and freshwater resources (Ismail *et al.*, 2013). In west central table land zone of Odisha, the lowlands adjacent to river banks and natural drainage lines are subjected to partial to complete submergence for a period of 3 to 12 days at the time of heavy rainfall both in catchment and command area of the Hirakud dam, mostly in the month of August causing poor yield to complete damage of rice and heavy economic losses to the poor farmer of the region as well as the state. The average rice productivity of submergence prone areas in eastern India is 0.5 to 0.8 t ha⁻¹, whereas it is about 2.0 t ha⁻¹ in favorable rain-fed low lands, which is much lower than the input intensive irrigated system (Bhowmick *et al.*, 2014). The low productivity of rice in these areas is mainly due to the use of traditional long duration land races or old

varieties and suboptimal agronomic practices in the nursery as well as in the main field, which adversely affects the post flood survival and subsequent stand establishment (Sarangi *et al.*, 2015). The adverse effects of flooding on rice vary by genotypes and of particular importance is the carbohydrate status of the plant before and after submergence, the developmental stage at which flooding occurs, duration and depth of submergence and level of turbidity of flood water (Colmer and Pedersen, 2008). The availability of tolerant varieties provide more opportunity for developing and validating proper management options for flood prone condition which could further boost and stabilize the productivity of rice in the submergence prone ecosystem. Proper nursery management is helpful for raising healthy and vigorous seedlings. Apart from having a big impact on survival and recovery after flooding, healthy seedlings can also produce up to 40% more rice even if complete submergence takes place during the vegetative stage (Ella *et al.*, 2010). Practices such as balanced nutrition, optimum seeding density in the nursery, proper seedling age and careful handling at transplanting have been reported to mitigate the adverse effects of floods and other abiotic stresses following transplanting (Sarangi *et al.*, 2015). Therefore present study was designed to develop the nursery management techniques such as proper nutrient management, seeding density in nursery and suitable age of seedling for transplanting for enhancing the post flood survival of rice seedling and maximizing the productivity of rice in submerged areas.

MATERIALS AND METHODS

The field experiment was conducted at the Instructional Farm of the College of Agriculture, Chiplima, Sambalpur, Odisha in the year 2019 in *kharif* season where submergence tolerant rice (Cultivar 'Swarna sub 1') was taken as test crop. The area is situated in the eastern part of the country which falls under the sub-humid climatic condition and it belongs to the West central table land Agro climatic Zone of Odisha. The experimental site falls under the sub-humid subtropical region with average annual rainfall of 1400 mm, concentrated mostly in the months of June to October. The experimental plot situated at an altitude of 155 m above mean sea level and is intersected by 20°21' N latitude and 80°85' E longitude. The soil at the experimental site is loamy sand. The soil pH of the experimental plot is 6.7. The bulk density and particle density of the soil were 1.55 and 2.44 g cm⁻³, respectively. The organic carbon (%), available nitrogen (kg ha⁻¹), phosphorus (kg ha⁻¹) and potassium (kg ha⁻¹) status were 0.60, 382, 19.7 and 175.6, respectively. The experiment was laid out in split-plot design with three replications having sixteen treatment combinations. The treatments consist of four nutrient management *viz.* Farmers' practice - 25 kg N ha⁻¹ with

no P_2O_5 and K_2O (N_1); Recommended fertilizer dose- $N:P_2O_5:K_2O$ at 80:40:40 $kg\ ha^{-1}$ (N_2); 75% of recommended dose of nitrogen - $N:P_2O_5:K_2O$ at 60:40:40 $kg\ ha^{-1}$ (N_3) and 125 % of recommended N - $N:P_2O_5:K_2O$ at 100:40:40 $kg\ ha^{-1}$ (N_4) were assigned in the main plot. In each treatment 25 $kg\ N$ through 5 tha^{-1} of FYM was applied including in the farmers' practice and remaining N along with full P and K were applied through chemical fertilizer. The combinations of seeding density in nursery and age of seedling at transplanting each at two levels were allotted in sub plots. Four sub plot treatments were the combinations of 40 $g\ m^{-2}$ seeding density (D_1); 60 $g\ m^{-2}$ seeding density (D_2); transplanting of 30 days old seedling (T_1) and transplanting of 40 days old seedling (T_2). The size of the individual plot was taken as 2 sq. m (2.0 m x 1.0 m) for the nursery and 20 sq. m (5.0 m x 4.0 m) with net plot area of 11.2 m^2 (3.5 m x 2.8 m) for the main field. Seedlings were raised with staggered wet bed nursery with 10 days interval and transplanted on the same day. Application of fertilizers and sowing of the pre germinated seeds were done as per the treatments. The Main field lay out was done as per the nursery lay out. Two seedlings per hill at a spacing of 20 cm x 15 cm were transplanted. Ten extra rows of 'Swarna' variety was planted on one side of the experimental plot as sensitive check to determine the time of de-submergence. A common Fertilizer dose of $N:P_2O_5:K_2O$ at 80:40:40 $kg\ ha^{-1}$ was applied in the main field. All P & K as basal and N in four equal split *i.e.* at basal, 7 days after de-submergence, maximum tillering stage and PI stage were applied in the experimental plot. Gap filling was done to ensure 100 % plant population before submergence. Plants were completely submerged at 10 DAT with a water depth of 1.1 meter for a period of 15 days. The biometric observation on seedling characters like seedling height, dry matter accumulation and leaf area of seedling were taken. The post survival % was recorded at seven days after de- submergence. The observations on grain and straw yield were taken. Economics of rice production in different treatments under submergence condition was also calculated. Data were subjected to analysis of variance (ANOVA) using MS-Excel worksheet.

RESULTS AND DISCUSSION

A. Dry matter of seedling at transplanting

Application of nitrogen at 100 $kg\ ha^{-1}$ (N_4) in rice nursery registered significantly higher dry matter accumulation seedling⁻¹ at transplanting than all other main plot treatments except the treatment receiving the recommended dose of nitrogen (80 $kg\ ha^{-1}$), this treatment was statistically at par with the treatment receiving 100 $kg\ nitrogen\ ha^{-1}$. Application of higher dose of nitrogen in the nursery increased the nitrogen availability and uptake by the seedlings which in turn

increased the production of photosynthates and also the dry matter accumulation. Panda *et al.* (1991) also indicated the higher dry matter accumulation with application of 100 $kg\ N\ ha^{-1}$ in the nursery as compared to other lower levels of nitrogen.

Seedlings raised with lower seeding density (40 $g\ m^{-2}$) in nursery produced significantly higher dry matter of seedlings at transplanting as compared to higher seeding density (60 $g\ m^{-2}$). This was mainly because of less plant population in lower seeding density as compared to higher seeding density. The limited plants with same level of growth factors *i.e.* nutrient, space and light utilized the available resources and promoted vigorous and speedy growth of seedlings leading to more dry matter accumulation. This result was in congruity with findings of Naem *et al.* (2010).

The older seedlings (40 days old) recorded significantly higher dry matter than that of younger (30 days) seedlings in this study. This was simply because of earlier sowing and spending more time in nursery by the older seedlings. Similar results were also reported by Pervin *et al.* (2010).

B. Seedling height at transplanting

The data on seedling height of rice presented in Table 1 revealed that the seedling height of rice varied significantly with nutrient management in nursery. The seedling height increased with increase in nitrogen levels up to 100 $kg\ N\ ha^{-1}$. However, the treatment receiving 80 $kg\ N\ ha^{-1}$ (N_2) was second in order and was at par with 100 $kg\ N\ ha^{-1}$ (N_4) at transplanting in this study.

Seeding density in nursery did not have significant influence on seedling height in this study. The seedlings of 40 days old (T_2) produced significantly higher seedling height than that of seedlings of 30 days old (T_1) in the nursery at transplanting.

C. Leaf area of seedling at transplanting

Application of 100 $kg\ N\ ha^{-1}$ in the nursery recorded the highest leaf area (Table 1), which was at par with 80 $kg\ N\ ha^{-1}$ and significantly higher than all other treatments in this study. The beneficial effect of higher doses of nitrogen in recording higher leaf area could be attributed to the greater availability of N, thereby inducing production of more soft tissues of leaves leading to their elongation (Mengel and Kirkby, 1978). As the level of N supply increased, the extra protein produced presumably enlarged the leaves, which prevailed larger area for photosynthesis and increased the leaf area. This corroborated the findings of Sarangi *et al.* (2015).

Lower seeding density in the nursery (40 $g\ m^{-2}$) and older seedlings (40 days old) recorded significantly higher leaf area seedling⁻¹ at transplanting than that of higher seeding density (60 $g\ m^{-2}$) and younger seedlings (30 days old), respectively.

Table 1: Dry matter production, Seedling height and leaf area of seedling at transplanting as influenced by nursery management.

Treatments	Dry matter accumulation (g plant ⁻¹)	Seedling height (cm)	Leaf area (cm ² seedling ⁻¹)
Nutrient Management (N)			
N ₁	0.797	27.2	19.4
N ₂	1.142	29.3	23.4
N ₃	0.934	28.5	20.7
N ₄	1.193	30.7	24.0
S. Em (±)	0.035	0.33	0.42
CD (P=0.05)	0.120	1.01	1.28
CV (%)	11.8	7.86	13.16
Seeding density (D)			
D ₁	1.070	29.5	22.9
D ₂	0.963	28.4	20.8
S. Em (±)	0.020	0.27	0.16
CD (P=0.05)	0.058	0.76	0.47
CV (%)	9.6	6.36	5.18
Age of seedling at transplanting (T)			
T ₁	0.874	27.5	20.6
T ₂	1.160	29.3	22.2
S. Em (±)	0.020	0.39	0.33
CD (P=0.05)	0.058	1.13	0.95
CV (%)	9.6	6.66	7.48

N₁: Farmer's practice - 25 kg N ha⁻¹ with no P₂O₅ and K₂O

N₂: Recommended dose of nitrogen with 40 kg each of P₂O₅ and K₂O - N:P₂O₅:K₂O at 80:40:40 kg ha⁻¹

N₃: 75% of recommended nitrogen with 40 kg each of P₂O₅ and K₂O - N:P₂O₅:K₂O at 60:40:40 kg ha⁻¹

N₄: 125 % of recommended nitrogen with 40 kg each of P₂O₅ and K₂O - N:P₂O₅:K₂O at 100:40:40 kg ha⁻¹

(In each treatment 25 kg N was applied through 5 t ha⁻¹ of FYM including in the farmers' practice)

D₁: 40 g m⁻² seeding density in nursery

D₂: 60 g m⁻² seeding density in nursery

T₁: Age of seedling at transplanting (30 days),

T₂: Age of seedling at transplanting (40 days)

D. Post flood survival

Nutrient management in the nursery had considerable influence on post flood survival of rice after transplanting in main field (Table 2). Farmers' practice (5 t ha⁻¹ FYM) recorded significantly lower survival than that of the treatments receiving nitrogen at different levels (N₂, N₃ and N₄) during post flood period. This might be due to production of weaker seedlings due to imbalanced fertilization. However, application of balanced fertilizer in the form of 40 kg P₂O₅ and 40 kg K₂O ha⁻¹ along with different levels of nitrogen, where 25 kg of recommended N was applied from 5 t ha⁻¹ FYM registered higher survival rate as compared to 5 t ha⁻¹ alone after 15 days of submergence. This was because of combined application of balanced chemical fertilizers along with FYM supplied the nutrient to the rice seedlings in a balanced and sustained manner which increased seedling vigour in the form of dry matter, seedling height and leaf area at transplanting (Table 1). These robust seedlings were capable of sustaining the ravages of flood due to more carbohydrate content at the time of flooding and also having quick regeneration ability as explained by Sarkar (1997); Bhowmick *et al.* (2014). In

this study the survival was the highest with application of 80 kg N ha⁻¹ which was significantly higher than that of all other nutrient treatments except 60 kg N ha⁻¹. It was interesting to note that the survival % decreased both at lower level of nitrogen *i.e.* 60 kg ha⁻¹ (N₃) and at higher level of nitrogen *i.e.* at 100 kg ha⁻¹ (N₄). Seedlings fertilized with 100 kg N ha⁻¹ recorded lower survival rate as compared to 80 kg N ha⁻¹ might be due to application of excess nitrogen beyond 80 kg N ha⁻¹ increased the nitrogen content in plant tissue rather than carbohydrate content, which made the plant susceptible to flooding. Similar findings were also reported by Ravi Kumar *et al.* (2012); Bhowmick *et al.* (2014).

In the sub plots, the lower seeding density (D₁) and older seedlings (T₂) registered significantly higher survival percent than the higher seeding density (D₂) and younger seedlings (T₁), respectively. The beneficial effect of lower seeding density was due to production of healthy and robust seedlings owing to availability of wider space and greater accessibility to the growth factors. Similarly, the older plants having more mature tissue and sachharides content survived under submergence avoiding the damage from flood (Ram *et al.*, 2009).

Table 2: Effect of nutrient management, seeding density in nursery and age of seedling on post flood survival of rice.

Treatments	Post flood survival
Nutrient Management (N)	
N ₁	9.116 (83.6)*
N ₂	9.782 (95.2)
N ₃	9.536 (90.5)
N ₄	9.459 (89.0)
S. Em (±)	0.074
CD (P=0.05)	0.255
CV (%)	2.692
Seeding density (D)	
D ₁	9.562 (91.0)
D ₂	9.409 (88.1)
S. Em (±)	0.036
CD (P=0.05)	0.104
CV (%)	1.849
Age of seedling at transplanting (T)	
T ₁	9.402 (88.0)
T ₂	9.569 (91.2)
S. Em (±)	0.036
CD (P=0.05)	0.104
CV (%)	1.849

* Figures in the parentheses are the original values (X). The data transformed to $\text{SQRT}(X + 0.5)$

N₁: Farmer's practice - 25 kg N ha⁻¹ with no P₂O₅ and K₂O

N₂: Recommended dose of nitrogen with 40 kg each of P₂O₅ and K₂O - N:P₂O₅:K₂O at 80:40:40 kg ha⁻¹

N₃: 75% of recommended nitrogen with 40 kg each of P₂O₅ and K₂O - N:P₂O₅:K₂O at 60:40:40 kg ha⁻¹

N₄: 125 % of recommended nitrogen with 40 kg each of P₂O₅ and K₂O - N:P₂O₅:K₂O at 100:40:40 kg ha⁻¹

(In each treatment 25 kg N was applied through 5 t ha⁻¹ of FYM including in the farmers' practice)

D₁: 40 g m⁻² seeding density in nursery, D₂: 60 g m⁻² seeding density in nursery

T₁: Age of seedling at transplanting (30 days), T₂: Age of seedling at transplanting (40 days)

E. Grain yield

The data on grain yield of rice presented in Table 3 expressed that it varied significantly among the different main plot treatments in this study. The main plot treatment which received 80:40:40::N:P₂O₅:K₂O kg ha⁻¹ (N₂) registered the highest grain yield, which was significantly higher than that of farmers' practice of 25 kg N through FYM at 5 t ha⁻¹ (N₁) and the treatments of 60:40:40::N:P₂O₅:K₂O kg ha⁻¹(N₃) and was at par with 100:40:40::N:P₂O₅:K₂O kg ha⁻¹(N₄). These seedlings having higher vigour, established faster after transplanting and showed higher survival rate during post submergence period as evident from Table 2. Ros *et al.* (2003); Sharma and Ghosh (1999) also reported the similar results. The treatment receiving 80 kg N ha⁻¹ in (N₂) in the nursery recorded the highest survival even higher than application of 100 kg nitrogen ha⁻¹ (N₄). This was mainly due to higher N content of leaves with higher dose of nitrogen beyond a certain limit (80 kg N ha⁻¹). The treatment N₂ having higher survival rate produced more number of tillers per unit area leading to higher number of panicles m⁻² which was an important criteria determining the grain yield of rice. Seedlings raised with balanced fertilization in nursery might have produced better growth trends during post submergence period and leading to higher dry matter accumulation during pre-anthesis period. The rice plants which recorded higher values of growth attributes during pre-

anthesis period also promoted the production of higher grain yield. Similar observations were reported by several workers (Adhikar *et al.*, 2013; Singh *et al.*, 2014; Bhowmick *et al.*, 2014).

Among the sub plot treatments the seeding density in the nursery did not have significant effect on grain yield of rice during the study. However, seedlings raised with seeding density of 40 g m⁻²(D₁) in the nursery, when transplanted produced higher grain yield than that of higher seeding density of 60 g m⁻² (D₂) under submerged condition. This is because seedlings grown with wider spacing were healthier and more vigorous and capable of higher post flood survival as well as higher growth and yield parameters resulting in production of higher grain yield as compared to higher seeding density. This was in accordance with the findings of and Adhikari *et al.* (2013).

Older seedlings had a highly significant and positive effect on grain yield in this study. The older seedlings increased grain yield by 5.2 %. These results were in agreement with (Bhagat *et al.*, 1991) who found that 40 days old seedlings produced higher grain yield as compared to 30, 50 and 60 days old seedlings. It must be noted in the present experiment that the sowing of seeds for older seedlings was done 10 days ahead (but transplanted at the same time as young seedlings) availing more favourable environment for growth and produced more vigorous seedlings. These seedlings also

registered higher post flood survival rate and ultimately the grain yield of rice. Similar opinions were put forwarded by Mustari *et al.* (2013); Sumon *et al.* (2013).

F. Straw yield

It was observed that the straw yield of rice varied significantly among the main plot treatments in the nursery. Application of 80:40:40::N:P₂O₅:K₂O kg ha⁻¹ (N₂) in the nursery produced significantly higher straw yield than that of all other treatments except the treatments receiving 100:40:40::N:P₂O₅:K₂O kg ha⁻¹ (N₄) in this study. This treatment (N₂) also produced the highest straw yield and was statistical at par with the treatments receiving 100:40:40::N:P₂O₅:K₂O kg ha⁻¹ (N₄). With regards to seeding density and age of seedlings both showed significant influence on straw yield of rice under 15 days of submergence. Lower seeding density (40 g m⁻²) produced 4 % higher straw yield as compared to higher seeding density (60 g m⁻²). Similarly the older seedlings produced 4.6 % higher

straw yield as compared to that of younger seedlings (30 days). Similar findings have also been reported by Singh *et al.* (2004); Sarangi *et al.* (2015).

G. Return rupees⁻¹ invested

It was indicated that among the nutrient management treatments, application of 80:40:40::N:P₂O₅:K₂O kg ha⁻¹ (N₂) in the nursery recorded the highest value of return rupees⁻¹ invested followed by the treatment receiving 100:40:40::N:P₂O₅:K₂O kg ha⁻¹ (N₄). Farmers' practice of 25 kg N through FYM at 5 t ha⁻¹ (N₁) recorded the lowest value, which was linked with the higher grain and straw yield and comparatively lower cost of production. Similar monetary benefit was also reported by Singh *et al.* (2005); Sarangi *et al.* (2015).

Among the sub plot treatments, the lower seeding density of 40 g m⁻² (D₁) in nursery and transplanting of seedlings of 40 days (T₂) recorded higher return rupees⁻¹ invested than that of higher seeding density of 60 g m⁻² (D₂) and seedlings of 30 days (T₁), respectively.

Table 3: Yield and economics of rice as influenced by nursery management.

Treatments	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Return rupees ⁻¹ invested
Nutrient Management (N)			
N ₁	3.53	4.45	1.39
N ₂	4.21	5.07	1.63
N ₃	3.90	4.77	1.51
N ₄	4.06	4.90	1.57
S. Em (±)	0.08	0.08	-
CD (P=0.05)	0.28	0.28	-
CV (%)	11.61	8.58	-
Seeding density (D)			
D ₁	4.00	4.89	1.54
D ₂	3.84	4.70	1.50
S. Em (±)	0.06	0.06	-
CD (P=0.05)	NS	0.18	-
CV (%)	7.19	6.40	-
Age of seedling at transplanting (T)			
T ₁	3.82	4.69	1.48
T ₂	4.02	4.91	1.56
S. Em (±)	0.06	0.06	-
CD (P=0.05)	0.17	0.18	-
CV (%)	7.19	6.40	-

N₁: Farmer's practice - 25 kg N ha⁻¹ with no P₂O₅ and K₂O

N₂: Recommended dose of nitrogen with 40 kg each of P₂O₅ and K₂O -N:P₂O₅:K₂O at 80:40:40 kg ha⁻¹

N₃: 75% of recommended nitrogen with 40 kg each of P₂O₅ and K₂O - N:P₂O₅:K₂O at 60:40:40 kg ha⁻¹

N₄: 125 % of recommended nitrogen with 40 kg each of P₂O₅ and K₂O - N:P₂O₅:K₂O at 100:40:40 kg ha⁻¹

D₁: 40 g m⁻² seeding density in nursery, D₂: 60 g m⁻² seeding density in nursery

T₁: Age of seedling at transplanting (30 days), T₂: Age of seedling at transplanting (40 days)

CONCLUSION

Application of N:P₂O₅:K₂O at 80:40:40 kg ha⁻¹ where 25 kg N applied through FYM @ 5 t ha⁻¹, seeding density of 40 g m⁻² in the nursery and transplanting of 40 days old seedlings resulted comparable growth parameters of seedling at transplanting. Such practices significantly increased the post flood survival of rice leading to record significantly higher grain and straw yield and return rupees⁻¹ invested of rice in flood prone low land condition. These practices can effectively be

implemented in other states of India as well as Bangladesh and in the regions having similar ecologies

FUTURE SCOPE

Profound research work has been conducted on various aspects of nursery management in paddy for enhancing yield in low land areas but less research work is done on physiology of survival of rice under complete submergence as well as effect of water quality, duration of submergence and stage of submergence on post flood survival of rice. Hence, further more studies need to be done on these aspects.

Acknowledgement. We are thankful to College of Agriculture (OUAT), Chiplima for providing necessary support for conducting this study.

Conflict of Interest. None.

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How to cite this article: B.S. Bishoyi, B. Duary, S.S. Nanda, U.K. Behera and C. Patra (2022). Nursery Management Options for Enhancing Post Flood Survival, Productivity and Economics of Rice (*Oryza sativa* L.) under Submergence in West Central Table Land Zone of Odisha. *Biological Forum – An International Journal*, 14(1): 197-203.