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Evaluation of Agronomic Management of Overaged Seedlings of Rice Varieties on yield Parameters and Nutrient Uptake in North Coastal A.P

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted on sandy loam soil at the college farm of Agricultural College, Naira, Srikakulam to study the yield attributes and Nutrient uptake of different rice varieties as influenced by the intervention of different agronomic management techniques under late sown, over aged seedlings conditions in a split-plot design, comprised of three different varieties MTU 1210 (M_1), MTU 1224 (M_2) and BPT 2411 (M_3) transplanted at the age of 45 days in the main field as main plots and with subplot treatments of seven different agronomic techniques adopted for study i.e. comprised Planting 33 hills m^{-2} with 6 seedlings per hill + 100% RDN (120 kg N as 70:30 in 2 splits) (S_1), Planting 44 hills m^{-2} with 3 seedlings per hill + 100% RDN (S_2), Planting 44 hills m^{-2} with 6 seedlings per hill + 100% RDN (S_3), Planting 33 hills^{-2} with 6 seedlings per hill+125% of RDN (150 kg N as 70:30 in 2 splits) (S_4), Planting 44 hills m^{-2} with 3 seedlings + 125% of RDN (S_5), Planting

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44 hills m^{-2} with 6 seedlings per hill + 125% of RDN (S_6). Planting 33 hills m^{-2} with 3 seedlings per hill + 100% RDN (S_7). Regarding yield attributes and Nutrient uptake, BPT 2411 outperformed MTU 1224 and MTU 1210 among the varieties. Under late sown over aged seedlings conditions the variety BPT 2411 cultivated with an agronomic management of planting 44 hills m^{-2} with 6 seedlings per hill + 125% of RDN of fertility levels of 150-60-50 N, P and K kg ha^{-1} attains the highest grain and straw yields.

Keywords: Agronomic techniques; Nutrient uptake; varieties; recommended dose of nitrogen; yield.

1. INTRODUCTION

Rice (*Oryza sativa L.)* is cultivated in more countries than any other grain crop. It belongs to the subfamily Oryzoideae of the Poaceae family of grasses. Rice is the most nutrient-dense grain after wheat and epidemiological studies have shown that the consumption of whole grains can reduce the risk of metabolic disorders [1]. Rice is the most often eaten grain in India. Rice is 23% more efficient in terms of calorie production compared to wheat and maize and about 35% of human calorie intake comes from these crops [2]. India's projected harvested rice fields cover 47.0 million hectares for the marketing year 2022-23 [3] and yield 4.21 tonnes per hectare. To sustainably feed its rapidly growing population of 1.5 billion people, India must increase its annual grain output to 120 million tonnes by 2025 from the current 108.32 million tonnes [4]. In Andhra Pradesh, rice is the most significant primary food crop. From the high altitude and tribal zone in the south to the lowland and coastal zone in the north, it is cultivated everywhere. The majority of rice in Andhra Pradesh comes from irrigated eco-systems as of 2020-21 statistics, canals (46.60%), tube wells (40.0%), tanks (8.43%), other wells (1.46%), and other sources (3.52%), yielding an average of 5130 kilograms per hectare per year [5], which is higher than the national average of 2566 kilograms per hectare per year in India and the global average of 4610 kg ha^{-1} per year, respectively [3]. Compared to India, the low rice yield shortfall may be traced back to the delayed start of the monsoon, a lack of uniformity in rainfall patterns, and a delay in the discharge of water into the canals. As a result, additional seedlings hill^{-1} were transplanted, and older seedlings from the nursery were used. To ensure healthy plant stands after transplanting, it is crucial to utilize well-managed seedbeds with optimal nutrition and enough seedlings at the right ages. Water shortage and rising competition for water resources are two of the key factors threatening the long-term viability of the rice farming industry [6]. In the coastal regions of India and Andhra Pradesh, rice is one of the most important food crops. About 4.25 lakh hectares of land is used to produce rice during Kharif in north coastal Andhra Pradesh, with a production of 4.2 tonnes per hectare per year [5]. The importance of continuing to develop new rice varieties to guarantee India's food security and support the region's economic development needs no special emphasis. Varieties play a vital role in maximizing yield by improving the input use efficiency. The adverse effect of late transplanting can also be minimised by selecting suitable cultivars as the magnitude of yield reduction varies with the rice cultivars. Since a variety's genetic potential determines how much of that potential is expressed and how a plant grows in response to environmental circumstances, varieties play a special role in maximizing output by increasing input usage efficiency. Key management strategies for overaged seedling rice production include maintaining effective plant densities (number of seedlings hill^{-1}), optimum date of sowing [7] and nitrogen application [8] Influencing sunlight interception, photosynthetic rate, tiller production, nutrient absorption, and other physiological phenomena and eventually, the growth and development of rice plants, plant densities (number of seedlings hill^{-1}) are a crucial component in rice production. When there are a lot of rice plants in a small area, they begin to shade each other out and lodge over time, which encourages more straw production and less grain. To increase production, it is vital to find the optimal seedling density per hill and nitrogen application rate for effective yield [9].

The present study proposed to study the growth parameters of different rice varieties as influenced by agronomic management techniques under overaged seedling conditions.

2. MATERIALS AND METHODS

The field experiment was conducted during the *kharif* seasons of 2022, on sandy loam soil at the college farm of Agricultural College, Naira, Srikakulam with a split-plot design comprising three rice varieties *viz.* MTU 1210 (M_1), MTU 1224 (M_2) and BPT 2411 (M_3) as main plots and seven agronomic techniques planting 33 hills m^{-2} with 6 seedlings per hill+ 100% RDN (120 kg N as 70:30 in 2 splits) (S_1), planting 44 hills m^{-2} with 3 seedlings per hill + 100% RDN (S_2), planting 44 hills m^{-2} with 6 seedlings per hill+ 100% RDN(S_3), Planting 33 hills^{-2} with 6 seedlings per hill + 125% of RDN (150 kg N as 70:30 in 2 splits) (S_4), planting 44 hills m^{-2} with 3 seedlings + 125% of RDN (S_5), planting 44 hills m^{-2} with 6 seedlings per hill + 125% of RDN (S_6), planting 33 hills m^{-2} with 3 seedlings per hill + 100% RDN (S_7) as sub-plots with three replications to assess the growth parameters and yield parameters. All the recommended packages of practices were followed to raise a good crop. The nursery field was thoroughly ploughed and well-levelled. The entire field area was demarcated into 3 plots each of size 3 m² (3 m × 1 m) and individual plots were separated by bunds respectively for subsequent transplantation technique of the establishment. The seed of the three varieties under investigation *i.e.,* MTU 1210, MTU 1224, and BPT 2411 was soaked in water for 24 hours, drained and incubated in moist gunny bags for 36 hours. The sprouted seeds were broadcasted uniformly over the well-prepared seedbeds. A fertilizer dose of 1.5: 0.5: 0.5 kg N, P_2O5 and K_2O per 100 sq m was applied as a basal dose. The seedling's densities of three and six per hill were planted at 45 days old in main field, based on the replications. The plots were irrigated with a 2.5 cm depth of water and irrigated again on the appearance of hairline cracks on the soil surface. This practice was continued till the flowering stage of the crop. Nitrogen as Urea was applied in two splits *i.e.,* 70% at the time of transplanting, and 30% at an active tillering stage in the subplots as N @150 kg ha^{-1} and N @120 kg $ha^{-1.}$ As per the treatments in the subplot, the entire quantity of phosphorus as a Single Super Phosphate was applied at the time of final puddling and potassium was applied in two splits, 50% at the time of transplanting and the remaining 50% at panicle initiation. The split pot design, developed by Fisher [10] was used to compile and analyse the collected data, consisting of both pre and post-harvest observations. Critical differences were determined for those parameters that were found to be statistically significant (p 0.05) to compare the impact of the various treatments.

3. RESULTS AND DISCUSSION

3.1 Grain Yield (kg ha^{-1})

During the year of study, Grain yield was significantly influenced by varieties and agronomic management techniques. However, their interaction effect was not conspicuous (Table 1). The grain yield of BPT 2411 was significantly higher than that of MTU 1224 and MTU 1210 with an increase of 7.79% over MTU 1224 and 21.85 % over MTU 1210 respectively. There was a significantly higher grain yield realized with that of MTU 1224 when compared to MTU 1210 which was 13.04% higher. Among the varieties, MTU 1210 registered the lowest grain yield. Among different agronomic management techniques, the highest grain yield was recorded with planting 44 hills m^{-2} with 6 seedlings per hill + 125% of RDN (S_6), which was significantly higher than all other agronomic management techniques and it was higher by 34.9% over control planting 33 hills m^{-2} with 3 seedlings per hill +100% RDN (S_7) and 7.24% over next best treatment planting 44 hills m^{-2} with 6 seedlings per hill + 100% RDN (S_3). The grain yield was comparable with planting 44 hills m^{-2} with 6 seedlings per hill + 100% RDN (S_3), planting 33 hills m^{-2} with 6 seedlings per hill + 125% of RDN (S_4) and planting 44 hills m^{-2} with 3 seedlings per hill+125% of RDN (S_5). The grain yield was at par with planting 33 hills m^{-2} with 6 seedlings per hill + 100% RDN (S_1) and planting 44 hills m^{-2} with 3 seedlings per hill + 100% RDN (S_2). Grain yield was significantly lowest with planting 33 hills m^{-2} with 3 seedlings per hill + 100% RDN (S_7). The higher grain yield with planting 44 hills m^{-2} with 6 seedlings per hill + 125% of RDN (S6) might be the result of better growth and yield stature might be due to higher levels of N application, which in turn led to better physiological processes and partitioning of photosynthates to sink. The higher yield with an increased number of hills or number of seedlings per hill might have been attributable to more panicle-bearing shoots m^{-2} [11]. Furthermore, closer spacing and a higher LAI may have enabled the rice plants to use light more effectively, resulting in higher yields [12].

3.2 Straw yield (kg ha^{-1})

The varieties and agronomic management techniques had significantly influenced the straw yield. However, the interaction effect was not apparent significantly (Table 1). The straw yield of BPT 2411 was significantly higher than that of MTU 1224 and MTU 1210 and showed an increase of 8.55% over MTU 1224 and 20.51% over MTU 1210 respectively. There was a significantly higher straw yield recorded by MTU

1224 which when compared to MTU 1210 was 11.03% higher. Among the varieties, MTU 1210 registered the lowest straw yield. Straw yield increased consistently with increasing plant densities and N application. The highest straw yield was recorded with the agronomic management technique of planting 44 hills m^{-2} with 6 seedlings per hill + 125% of RDN (S_6) and was superior to all other agronomic management techniques and on par with planting 33 hills m^{-2} with 6 seedlings per hill + 125% of RDN (S_4) and Planting 44 hills m^{-2} with 6 seedlings per hill + 100% RDN (S_3). (S_2) Planting 44 hills m^{-2} with 3 seedlings per hill + 100%RDN and planting 33 hills m^{-2} with 6 seedlings per hill + 100% RDN (S_1) have even lower and similar straw yields than planting 44 hills m^{-2} with 3 seedlings per hill + 125% of RDN (S_5). Planting 33 hills m^{-2} with 3 seedlings per hill + 100% RDN (S_7) has the lowest straw yields which was inferior to all other agronomic management techniques. The percentage increase in straw yield of planting 44 hills m^{-2} with 6 seedlings per hill + 125% of RDN (S_6) is 5.57 higher than the next best treatment and 31.40 higher than that of the control treatment. This increase was probably due to more dry matter accumulation per unit area due to better nutrient absorption from the soil, which increases the metabolic process, rate of light absorption, photosynthetic activities, and a greater number of leaves as reported by Hussain et al. [13]. The lowest straw yield was obtained from low seedling $hill^{-1}$ due to the lowest number of total tillers m^{-2} as concluded by Yahyazadeh et al. [14].

Table 1. Grain yield (kg ha^{-1}), Straw yield (kg ha^{-1}) of rice varieties as influenced by Agronomic management of overaged seedlings during *kharif* 2022-23

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Main treatments (Varieties)		
(M_1) MTU 1210	4891	5888
(M_2) MTU 1224	5529	6537
(M_3) BPT 2411	5960	7096
SEm (±)	82.42	117.9
CD (P=0.05)	323.6	463.2
CV (%)	6.92	8.31
Sub Plot treatments (Agronomic Management techniques)		
(S_1) Planting 33 hills m^{-2} with 6 seedlings per hill+ 100% RDN	5238	6234
(S_2) Planting 44 hills m^{-2} with 3 seedlings per hill + 100% RDN	5122	6260
(S_3) Planting 44 hills m^{-2} with 6 seedlings per hill+ 100% RDN	5755	6834
(S_4) Planting 33 hills m^{-2} with 6 seedlings per hill+125% of RDN	5753	6856
(S_5) Planting 44 hills m^{-2} with 3 seedlings per hill+125% of RDN	5604	6617
(S_6) Planting 44 hills m^{-2} with 6 seedlings per hill +125% of RDN	6172	7238
(S_7) Planting 33 hills m^{-2} with 3 seedlings per hill+100% RDN	4575	5508
SEm (±)	136.1	166.8
CD (P=0.05)	390.6	478.5
CV (%)	7.48	7.69
Interaction		
SEm±	235.86	288.98
CD (P=0.05)	NS	NS

3.3 Nutrient Uptake Studies

3.3.1 Nitrogen uptake

Nitrogen uptake was estimated at flowering and harvest (both grain and straw). Nitrogen uptake by the varieties tended to increase with the advancement in age of the crop growth up to harvest. It was significantly influenced by varieties and agronomic management. The interaction effect on N uptake was not significant. N uptake is a critical parameter in rice cultivation as it reflects the amount of nitrogen taken up by the rice plants from the soil during the flowering stage and harvesting stage (grain and straw). Varieties have a great impact on the absorption of N and utilization for efficient production. From the data, it was observed that the variety BPT 2411 maintained the highest N uptakes at all the crop stages from the flowering stage to the harvesting stage (grain and straw) and was superior to MTU 1224 and MTU 1210. MTU 1210 recorded the lowest N uptake values in both the flowering and harvesting stages (Table 2). The data recorded with the efficient agronomic management techniques, it was observed that at the flowering stage and in the harvesting stage (grain and straw) planting 44 hills m^{-2} with 6 seedlings per hill +125% of RDN (S6) has the highest N uptake which is on par with and followed by planting 33 hills m^{-2} with 6 seedlings per hill + 125% of RDN (S4), planting 44 hills m^{-2} with 3 seedlings per hill+125% of RDN (S5) and planting 44 hills m^{-2} with 6 seedlings per hill + 100% RDN (S3). At the harvesting stage at grain, the N uptake values were superior in planting 44 hills m^{-2} with 6 seedlings per hill + 125% RDN (S6) than all other agronomic management technique techniques. Planting 33 hills m^{-2} with 3 seedlings per hill + 100% RDN (S7) has the lowest N uptake values among all the agronomic management techniques in all the stages of the crop. The differences in N uptake among the varieties may be attributed to genetic factors, as different rice varieties can have varying abilities

Table 2. N uptake as influenced by Agronomic management of overaged seedlings during *kharif* 2022-23

Treatments	Flowering	Grain	Straw
Main Plots: Three (varieties):			
(M_1) MTU 1210	81.73	60.72	67.18
(M_2) MTU 1224	92.28	68.64	73.96
(M_3) BPT 2411	97.28	74.03	80.95
SEm (±)	0.89	0.8	0.91
CD (P=0.05)	3.51	3.14	3.58
CV (%)	4.53	5.41	5.65
Sub Plot treatments (Agronomic Management techniques)			
(S_1) Planting 33 hills m^{-2} with 6 seedlings per hill+ 100% RDN	90.6	64.55	70.95
(S_2) Planting 44 hills m^{-2} with 3 seedlings per hill + 100% RDN	82.95	63.24	70.40
(S_3) Planting 44 hills m^{-2} with 6 seedlings per hill+ 100% RDN	93.53	69.83	76.71
(S_4) Planting 33 hills m^{-2} with 6 seedlings per hill+125% of RDN	96.92	71.99	77.80
(S_5) Planting 44 hills m^{-2} with 3 seedlings per hill+125% of RDN	95.81	70.96	77.69
(S_6) Planting 44 hills m^{-2} with 6 seedlings per hill +125% of RDN	99.24	77.69	80.78
(S_7) Planting 33 hills m^{-2} with 3 seedlings per hill+100% RDN	73.95	56.32	63.88
SEm (±)	2.01	1.21	1.79
CD (P=0.05)	5.76	3.48	5.13
CV (%)	6.67	5.38	7.24
Interaction			
SEm±	3.48	2.1	3.1
CD (P=0.05)	NS	NS	NS

to absorb and utilize nitrogen from the soil. Additionally, environmental conditions and agronomic practices such as nitrogen fertilization can also influence N uptake. Higher N uptake at the flowering stage is generally desirable, as it supports the plants reproductive growth and helps in the development of healthy and productive rice panicles. Adequate nitrogen uptake during flowering contributes to better grain filling and higher grain yield. It is important to consider N uptake along with other growth and yield parameters to make informed decisions regarding rice variety selection and nutrient management practices for optimizing rice production [15].

3.3.2 Phosphorous uptake

Phosphorus uptake was significantly influenced by varieties, and agronomic management i.e. plant density in combination with N fertility levels during the year of study (Table 3). The phosphorus uptake increased with the age of the crop and the highest uptake was observed at harvest. The phosphorus uptake of BPT 2411 was highest in both the stages of flowering and at harvesting (grain and straw) respectively. In the flowering stage, the uptake of phosphorus by BPT 2411 was on par with MTU 1224. The lowest uptake was recorded in the variety MTU 1210.Phosphorus uptake is the product of nutrient content and dry matter production. The per cent increase in P_2O_5 uptake with BPT 2411 over MTU 1224 and MTU 1210 at harvesting was 6.32 and 24.98, respectively. A progressive increase in the P uptake was observed with added levels of nitrogen up to the highest level and these results are in agreement with the findings of Bommayasamy et al. [16]. Among the agronomic management techniques, the highest phosphorus uptake was obtained in planting 44 hills m^{-2} with 6 seedlings per hill +125% of RDN (S_6) was significantly superior and on par with planting 33 hills m^{-2} with 6 seedlings per hill + 125% of RDN (S_4) and planting 44 hills m^{-2} with 3 seedlings per hill + 125% of RDN (S_5) in all stages of crop growth. The least uptake of

Table 3. Phosphorous uptake as influenced by Agronomic management of overaged seedlings during *kharif* 2022-23

Treatments	Flowering	Grain	Straw
Main Plots: Three (varieties):			
(M_1) MTU 1210	21.29	14.97	11.53
(M_2) MTU 1224	22.38	18.41	12.74
(M_3) BPT 2411	23.14	19.11	14.01
SEm (±)	0.32	0.27	0.35
CD (P=0.05)	1.25	1.07	1.38
CV (%)	6.56	7.3	12.67
Sub Plot treatments (Agronomic Management techniques)			
(S_1) Planting 33 hills m^{-2} with 6 seedlings per hill+ 100% RDN	21.25	16.47	11.53
(S_2) Planting 44 hills m^{-2} with 3 seedlings per hill + 100% RDN	20.37	15.83	11.37
(S_3) Planting 44 hills m^{-2} with 6 seedlings per hill+ 100% RDN	22.59	16.77	12.68
(S_4) Planting 33 hills m^{-2} with 6 seedlings per hill+125% of RDN	23.71	18.37	13.93
(S_5) Planting 44 hills m^{-2} with 3 seedlings per hill+125% of RDN	23.26	18.13	13.75
(S_6) Planting 44 hills m^{-2} with 6 seedlings per hill +125% of RDN	24.82	19.38	14.87
(S_7) Planting 33 hills m^{-2} with 3 seedlings per hill+100% RDN	19.88	15.20	11.23
SEm (±)	0.57	0.61	0.4
CD (P=0.05)	1.64	1.76	1.15
CV (%)	7.7	10.71	9.42
Interaction			
SEm±	0.99	1.06	0.69
CD (P=0.05)	NS	NS	NS

phosphorous was observed with the agronomic technique of planting 33 hills m^{-2} with 3 seedlings per hill + 100% RDN (S7). The higher plant density and the increase in the N uptake had an influence on the uptake of phosphorous in different crop growth stages. The significant increase in P uptake might be due to higher root proliferation of the crop. A progressive increase in the P uptake was observed with added levels of nitrogen up to the highest level and these results are in coordination with the findings of Bommayasamy et al. [16]. The interaction effect was not conspicuous between the varieties and agronomic management techniques.

3.4 Potassium Uptake

Potassium content affects the quality and nutritional value of crops. It contributes to the synthesis of proteins, carbohydrates, and vitamins, thus influencing grain quality attributes such as size, weight, texture, and taste. Over-aged rice seedlings with sufficient potassium uptake can exhibit improved grain quality and nutritional composition. However, as per the data, the Potassium uptake was significantly influenced by a combination of varieties and agronomic management techniques, and their interaction effect was also not significant on the overaged seedlings. Adequate potassium uptake ensures optimal photosynthetic efficiency, leading to improved plant growth, biomass production, and ultimately, higher yield potential. The potassium uptake was highest by the variety BPT 2411 in both the stages of flowering and harvesting (grain and straw) respectively. The lowest uptake was recorded in the variety MTU 1210. A progressive increase in the K uptake was observed with the crop growth stages. (Table 4) In flowering and grain among the agronomic management techniques the highest potassium uptake was in planting 44 hills m^{-2} with 6 seedlings per hill+ 100% RDN (S_3) and was on par with planting 44 hills m^{-2} with 3 seedlings per hill + 125% of RDN (S_5) and planting 44 hills m^{-2} with 6 seedlings per hill + 125% of RDN (S_6). In

Table 4. Potassium uptake as influenced by Agronomic management of overaged seedlings during *kharif* 2022-23

Treatments	Flowering	Grain	Straw
Main Plots: Three (varieties)			
(M_1) MTU 1210	110.14	22.08	117.76
(M_2) MTU 1224	113.40	22.50	130.27
(M_3) BPT 2411	119.17	23.84	141.91
SEm (±)	1.70	0.28	2.18
CD (P=0.05)	6.69	1.09	8.54
CV (%)	6.83	5.56	7.67
Sub Plot treatments (Agronomic Management techniques)			
(S_1) Planting 33 hills m^{-2} with 6 seedlings per hill+ 100% RDN	112.65	22.59	124.69
(S_2) Planting 44 hills m^{-2} with 3 seedlings per hill + 100% RDN	107.25	21.50	125.21
(S_3) Planting 44 hills m^{-2} with 6 seedlings per hill+ 100% RDN	122.33	24.53	136.69
(S_4) Planting 33 hills m^{-2} with 6 seedlings per hill+125% of RDN	111.32	22.32	137.13
(S_5) Planting 44 hills m^{-2} with 3 seedlings per hill+125% of RDN	117.50	23.56	131.24
(S_6) Planting 44 hills m^{-2} with 6 seedlings per hill +125% of RDN	120.41	23.81	144.77
(S_7) Planting 33 hills m^{-2} with 3 seedlings per hill+100% RDN	108.20	21.36	110.17
SEm (±)	2.88	0.57	3.34
CD (P=0.05)	8.26	1.64	9.57
CV (%)	7.56	7.52	7.70
Interaction			
SEm±	4.99	0.99	5.78
CD (P=0.05)	NS	NS	NS

straw, the potassium uptake was highest in planting 44 hills m^{-2} with 6 seedlings per hill + 125% of RDN (S_6) and was on par with planting 44 hills m^{-2} with 6 seedlings per hill+ 100% RDN (S_3) and planting 33 hills m^{-2} with 6 seedlings per hill + 125% of RDN (S_4).In both the flowering and in harvest (grain and straw) the least uptake of potassium was noticed in the agronomic management technique planting 33 hills m^{-2} with 3 seedlings per hill+100% RDN (S_7) amongst all other techniques. The higher plant density and the increase in the N uptake had an influence on the uptake of phosphorous in different crop growth stages. The significant increase in P uptake might be due to higher root proliferation of the crop. A progressive increase in the P uptake was observed with added levels of nitrogen up to the highest level and these results are in coordination with the findings of Bommayasamy et al. [16]. The interaction effect was not significant between the varieties and agronomic management techniques combination as in coordination with Saha et al. [17].

4. CONCLUSION

Ideal variety and agronomic management of over-aged seedlings is an important strategy to enhance productivity and enhance resource input efficiency. The identification of the best suitable variety and application of combinations of agronomic management (planting density along with N fertility level) are some of the principal elements of this strategy. Results obtained from the current study exhibit the significance of the growth, productivity, and nitrogen uptake with the varieties BPT 2411, MTU 1224 and MTU 1210 in combination with the agronomic management (planting density along with N fertility). An increase in plant density, seedling density and Nitrogen indicated an increased performance of yield and yield attributes. Both grain and straw yield. Maximum performance for yield and yield attributes was achieved by the variety BPT 2411 with the agronomic management technique of planting 44 hills m^{-2} with 6 seedlings per hill + 125% of RDN. It can be concluded that under late sown conditions planting over-aged seedlings, higher yield and profits can be achieved by selecting the variety BPT 2411, adopting the agronomic management technique of planting 44 hills m^{-2} with 6 seedlings per hill and application of 125% of RDN (150-60-50 kg N, P and K ha^{-1}). Furthermore, late-sown Rice cultivation with over-aged seedlings studies using real-time nutrient management tools in combination with innovative methods of crop establishment may be conducted in different soil types including in problematic soils.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Carcea M. Nutritional value of grain-based foods. Foods. 2020;9(4):504.
2. Soto-Gómez D, Pérez-Rodríguez P. Sustainable agriculture through perennial grains: Wheat, rice, maize, and other species. A review. Agriculture, Ecosystems & Environment. 2022;325: 107747. Available:https://doi.org/10.1016/J.AGEE.2021.107747
3. USDA, Agricultural marketing service farm service agency, World Agricultural Supply and Demand Estimates; 2023. Available:https://www.usda.gov/oce/commodity/wasde/wasde1123
4. Ministry of Agriculture and Farmers welfare, second advance estimates of production of food grains for 2022-23; 2023. Available:https://agricoop.gov.in Accessed on:14 February 2023
5. Directorate of Economics and Statistics. Agricultural Statistics at a Glance 2020-21 Andhra Pradesh. 2021:40 Available:https://des.ap.gov.in/jsp/social/ASAG2020-21 Accessed on: 15th September 2021.
6. Mallareddy M, Thirumalaikumar R, Balasubramanian P, Naseeruddin R, Nithya N, Mariadoss, A, Eazhilkrishna N, Choudhary AK., Deiveegan M, Subramanian E, Padmaja B. Maximizing water use efficiency in Rice farming: A comprehensive review of innovative irrigation management technologies. Water. 2023;15(10):1802.
7. Liu K, Song C, Ye P, Liu H, Xia Z, Waseem H, Deng Y, Liu Z, Wang, L, Wang B, Yang X, Zhu J. Optimizing Rice Sowing Dates for High Yield and Climate

Adaptation in Central China. Agronomy. 2023;13(5).
Available:https://doi.org/10.3390/agronomy13051339

8. Zhu K, Zhou Q, Shen Y, Yan J, Xu Y, Wang Z, Yang J. Agronomic and physiological performance of an indica–japonica rice variety with a high yield and high nitrogen use efficiency. Crop Science. 2020;60(3):1556–1568.
Available:https://doi.org/10.1002/csc2.20150
9. Chen Y, Liu Y, Dong S, Liu J, Wang Y, Hussain S, Wei H, Huo Z, Xu K, Dai, Q. Response of Rice yield and grain quality to combined nitrogen application rate and planting density in saline area. Agriculture. 2022;12(11):1788.
10. Fisher RA. Theory of statistical estimation. In Mathematical proceedings of the Cambridge Philosophical Society.1925; 22(5):700-725.
11. Chen Y, Liu Y, Dong S, Liu J, Wang Y, Hussain S, Wei H, Huo Z, Xu K, Dai Q. Response of Rice Yield and Grain Quality to Combined Nitrogen Application Rate and Planting Density in Saline Area. Agriculture (Switzerland). 2022;12(11).
Available:https://doi.org/10.3390/agriculture12111788
12. Zhu H, Wen T, Sun M, Ali I, Sheteiwy MS., Wahab A, Tan W, Wen C, He, X., and Wang, X. Enhancing Rice Yield and Nitrogen Utilization Efficiency through Optimal Planting Density and Reduced Nitrogen Rates. Agronomy. 2023;13(5): 1387.
13. Hussain T, Hussain N, Ahmed M, Nualsri C, Duangpan S. Impact of nitrogen application rates on upland Rice performance, planted under varying sowing times. Sustainability, 2022;14(4): 1997.
14. Yahyazadeh S, Mobasser HR, Rahimi Petroudi E, Daneshmand A. Effect of Nitrogen Fertilizer and Plant Density on Growth Characteristics, Yield Components and Grain Yield of Rice. Journal of Crop Production and Processing. 2023;13(1):1–14.
15. Jahan A, Islam A., Sarkar MIU, Iqbal M, Ahmed MN, Islam MR. Nitrogen response of two high yielding Rice varieties as influenced by nitrogen levels and growing seasons. Geology, Ecology, and Landscapes. 2022;6(1):24–31.
16. Bommayasamy N, Singh LB, Rahman FH. Effect of planting methods and seedling age on growth, yield and nutrient uptake in Rice under high rainfall areas of Bay Islands. International Journal of Plant & Soil Science. 2020;32(6):96-102.
17. Saha KK, Paul SK, Sarkar Md AR. Influence of spacing of planting on the yield performance of some aromatic Rice varieties in boro season. Sustainability in Food and Agriculture. 2020;1(1):10–14.

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