Evaluation of new rice varieties under delayed transplanting on yield parameters and nutrient uptakein North coastal zone, India

ABSTRACT

A field experiment was conducted on sandy loam soil at the college farm of Agricultural College, Naira, Srikakulam to study the yield and yield attributes of old aged seedlings as influenced by different varietiesin a split-plot design, comprised of three age of seedlings(30,45 and 60 days old) assigned to main Plots and eight varieties (V_1: MTU-7029, V_2: BPT-5204, V_3: MTU-1061, V_4: MTU-1121, V_5:MTU-1223, V_6:MTU-1224, V_7:MTU-1262 and V_8:RGL-2537) were assigned to sub plots. Among the three age of seedlings for transplanting, planting of 30 days seedlings proved superior by recording higher growth parameters and yield structure, yield and economic returns compared to planting of 45 days and 60 days old seedlings.Among the varieties tested, the higher grain yield,straw yield and economic returns was noticed with MTU-1223 (V_5) followed by RGL-2537 (V_8) and MTU-1224 (V_6).The differences in N uptake among the varieties may be attributed to genetic factors, as different rice varieties can have varying abilities to absorb and utilize nitrogen from the soil.

Keywords: Age of seedlings,Varieties,Yield, Nitrogen uptake, Economic returns.

Introduction

Rice (*Oryza sativa* L.) is the staple cereal for two-thirds of India's population, with the balance of the populace consuming a mixed basket of rice, wheat, and other cereals. Rice is predominantly a *kharif* season crop and is the most important food crop cultivated across India, contributing to over 40 per cent of total food grain production. Although, India ranked 1st in area and 2nd in production but struggling to have notable productivity among rice-growing countries. Planting of *kharif*rice crop closely follows the onset of southwest monsoon in June/July and its subsequent progress through September to augment the water requirement at critical crop growth stages.

India's projected harvested rice fields cover 47.0 million hectares for the marketing year 2022-23 (USDA,2023) and yield 4210kg ha^{-1}. To sustainably feed its rapidly growing population of

1.5 billion people, India must increase its annual grain output to 120 million tons by 2025 from the current 108.32 million tons (Ministry of Agriculture and Farmers Welfare, 2022-23). 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 kg ha^{-1}per year (Directorate of Economics and Statistics, A.P, 2021), which is higher than India's projected average of 4210 kg ha^{-1} per year and the global average of 4610 kg ha^{-1} per year, respectively (USDA, 2023). However, in the North coastal regions of Andhra Pradesh(Srikakulam, Vizianagaram and Vishakhapatnam), Rice is one of the most important food crops with 3.20 lakh hectares of the actual area mostly sown during *kharif* (Directorate of Economics and Statistics,A.P,2023) withan average production of 3850 kg ha^{-1} per year.

Optimumwindow for nursery sowing and transplanting is critical for achieving higher grain yield. Rice requires specific weather normal's at different phenophases such as panicle initiation, panicle exertions from flag leaf sheath, flowering and maturity. Rice grown after optimum planting window usually suffers from slow growth and poor crop stand and is prone to pests and diseases.

Sah *etal*. (2023) also reported that seeding age at transplanting is one of the most important factors that substantially regulate potential agronomic traits, i.e. tillering, panicle number and grain yield per unit of the land area.

In North-Coastal Andhra Pradesh, most of the rice-growing area is under uncertain irrigation systems. Whenever monsoon is delayed, farmers are compelled to transplant rice late in the season with over-aged seedlings due to late release of canal water. Delayed transplanting usually extends the growth of seedlings in seedbed and shortens their growth period in main field which results in reduction in yield. Therefore, under such unavoidable circumstances, farmers are to be insured against yield loss by identifying rice varieties which can produce satisfactory yield even when transplanted overage seedlings. Hence, it is felt pertinent to evaluate recently released high-yielding rice varieties for their suitability under delayed transplanting conditions with over-age seedlings in the north coastal districts of Andhra Pradesh.

The present study proposed to study the yield parameters and nutrient uptake of old aged seedlings as influenced by varieties.

MaterialsandMethods:

A field experiment was conducted on sandy loam soil at the college farm of Agricultural College, Naira, Srikakulam to study the yield and yield attributes of old aged seedlings as influenced by different varietiesin a split-plot design, comprised of three age of seedlings(30,45 and 60 days old) assigned to main Plots and eight varieties (V_1: MTU-7029, V_2: BPT-5204, V_3: MTU-1061, V_4: MTU-1121, V_5:MTU-1223, V_6:MTU-1224, V_7:MTU-1262 and V_8:RGL-2537) were assigned to sub plots. Among the threeage of seedlings for transplanting, planting of 30 days seedlings proved superior by recording higher growth parameters and yield structure, yield and economic returns compared to planting of 45 days and 60 days old seedlings.Among the varieties tested, the higher grain yield,straw yield and economic returns was noticed with MTU-1223 (V_5) followed by RGL-2537 (V_8) and MTU-1224 (V_6) toassesstheyieldand yield parameters.All therecommended packages of practices were followed toraise a good crop. Nursery field was thoroughly puddled and well levelled. The entire field area was demarcated into 24 plots each of size 3 m² (3 m×1 m) and individual plots were separated by bunds for 3 different aged seedlings of 30, 45 and 60 days respectively. The seed of eight varieties under investigation *i.e.*, MTU 7029,BPT 5204, MTU-1061, MTU-1121, MTU-1223, MTU-1224, MTU-1262 and RGL-2537 were 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 fertilizerdose of 1.5: 0.5: 0.5 kg N, P_2O_5 and K_2O per 100 m^{-2} was applied as basal dose. The seedlings were uprooted according to the treatments and transplanted in the main field.

The plots were irrigatedwith a 2.5 cm depth of water and irrigated again on the appearanceofhairlinecracksonthesoilsurface. Thispractice was continued till the flowering stage of thecrop. 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 (1925) 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.

Results and Discussion

Grain yield ($kgha^{-1}$):

Duringtheyear of study, Grain yield was significantly influenced by age of seedlings and varieties. However, their interaction effect was conspicuous (Table 1). Among different aged seedlings tried, rice crop established by transplanting with 30 days old seedlings (A_1) exhibited its statistical superiority in producing higher grain yield, while 60 days old seedlings (A_3) produced the lower grain yield. There was a gradual and progressive decline in grain yield of rice with every 15 days increase in age of nursery from 30 to 45 days and to 60 days which was worked out to be 8.3% and 28% respectively.

Table 1. Grain yield (kg ha^{-1}), Straw yield (kg ha^{-1}) and Harvest index (%) as influenced by age of seedlings and varieties

Treatments	**Grain yield(kg ha^{-1})**	**Straw yield(kg ha^{-1})**	Harvest index(%)
Age of seedling(A)			
A_1 : 30 days	6169	7512	44.99
A_2 : 45 days	5656	7017	44.18
A_3 : 60 days	4430	5800	42.08
SEm (±)	91.53	110.25	0.56
CD (P=0.05)	359.38	432.9	2.19
CV (%)	8.28	7.97	6.23
Variety (V)			
V_1 : MTU-7029	5353	6709	43.89
V_2 :BPT-5204	5208	6568	43.74
V_3 :MTU-1061	5403	6771	43.69
V_4 :MTU-1121	4969	6328	43.67
V_5 :MTU-1223	5791	7143	43.99
V_6 :MTU-1224	5560	6915	43.51

V_7 :MTU-1262	5478	6840	43.67
V_8 :RGL-2537	5583	6939	43.84
SEm (±)	93.30	93.7	0.69
CD (P=0.05)	266.27	267.43	**NS**
CV (%)	5.17	**4.15**	4.74
Interaction			
SEm (±)	**161.59**	**162.30**	**1.20**
CD (P=0.05)	**S**	**S**	**NS**

With regards to influence of varieties on grain yield of rice, marked differences were observed among the varieties tried. The higher grain yield was noticed with MTU-1223 (V_5) which was however showed statistically parity with MTU-1224 (V_6) and RGL-2537 (V_8). The lowest Grain yield was associated with MTU-1121 (V_4) which was however, comparable with BPT-5204 (V_2).

Significantly lower grain yield was observed in MTU-1121 (V_4) when nursery of 60 days old was transplanted which was however, statistically comparable with MTU-1262 (V_7) at the same age nursery. A massive 58.30% reduction in grain yield of rice was noticed when MTU-1262 was transplanted with 30 days old nursery compared to MTU-1121 transplanted with 60 days aged seedlings.

Significantly higher grain yield registered with MTU-1223 (V_5) could be attributed to the innate genetic potential of this cultivar in outperforming over rest of the varieties tested except MTU-1224 (V_6) and RGL-2537 (V_8) which were found on par with MTU-1223. Sah *et al.* (2023)

Massive reduction (41.69%) in grain yield of rice observed with MTU- 1121 when transplanted with 60 days old seedlings compared to 30 days old seedlings of MTU- 1224 might be due to the inability of MTU- 1121 to adapt to nursery that was over aged (60 days old) in performing to its potential. Aktar *et al.* (2022) andVishwakarma*et al.* (2016) also reported similar findings.

Straw yield(kgha^{-1}):

Straw yield was altered significantly among different aged seedlings tried and conspicuously influenced by varieties, while the interaction effect between these factors was also statistically measurable. (Table 1). Significantly higher straw yield was recorded in plots when with 30 days old seedlings were transplanted (A_1), while it was the lowest in A_3 (60 days old seedlings)**.**Straw yield was found to be the highest in V_5 (MTU-1223) which was, however, comparable with V_6 (MTU-1224), and V_8 (RGL-2537) while, significantly lower straw yield was observed in MTU-1121 (V_4) which was however, on par with BPT-5204 (V_2).

As regards the interaction effect between age of nursery at transplanting and varieties, the differences in straw yield were found to be statistically measurable (Table.2). Significantly higher straw yield was noticed with MTU-1262 (V_7) when 30 days old seedlings (A1) were transplanted which was however, found statistical parity with MTU-1061 (V_3) MTU-1223 (V_5), MTU-1224 (V_6) and MTU-7029 (V_1) at the same age of nursery.

Significantly higher straw yield registered with MTU-1223 (V_5), V_6 (MTU-1224), and V_8 (RGL-2537) could be attributed to their vigorous and faster growth characters dominated over rest of the varieties tested. Sah *et al.* (2023) and Oni *et al.* (2023).

The Significantly higher straw yield was noticed with MTU-1262 (V_7) when 30 days old seedlings (A_1). However, lesser straw yield was observed in MTU-1121 (V_4) and MTU-1262 (V_7) when nursery of 60 days old was transplanted. Aktar *et al.* (2022) also reported similar findings.

Harvest Index:

Data pertaining to Harvest index of rice as influenced by age of nursery at transplanting as well as varieties are presented in table 2. Scrutiny of the data revealed that age of nursery at transplanting was found to exert profound influence on Harvest index, while the influence of varieties as well as the interaction effect between age of nursery and varieties was found to be statistically not detectable.

Significantly higher values for Harvest index were noticed when seedlings were transplanted at 30 days age (A_1), which was however, on par with 45 days age (A_2) while the differences in HI between 45 days old seedlings (A_2**)** and 60 days old seedlings (A_3) were statistically comparable and significantly inferior to30 days age (A_1).Similar findings reported earlier by Singh *et al.* (2023) Ankit singh*et al*. (2023) and Mupeta *et al.* (2022).

Nutrientuptakestudies:

Nitrogen uptake (kg ha^{-1})

Distinct disparities were observed among age of nurseries at transplanting with regard to N uptake at flowering as well as by grain and straw table 2.Perusal of the data revealed that age of seedlings at the time of transplanting as well as varieties were found to exert a significant influence on N uptake of rice at both the stages of sampling (flowering and maturity). However, the interaction affect between age of nursery and varieties was not statistically traceable.

N uptake of rice at flowering, by grain and by straw the highest uptake of N was associated with 30 days aged seedlings (A_1) which was however, on par with 45 days aged seedlings (A_2). While, the uptake of N was minimum with the 60 days old aged seedlings (A_3).This was due to better translocation of nutrients from source to sink in 30 day old seedlings as compared to 45 and 60 day old seedlings because of early planting of younger seedlings in less competitive environment (main field) as compared to planting aged seedlings. Singh *et al.* (2023) and Pradhan *et al.* (2021) also expressed similar views earlier.

With regards to the influence of varieties on N uptake of rice at flowering, by grain and by straw marked differences were observed among the rice varieties tested. N Uptake was found to be the highest with MTU-1223 (V_5) which was followed by RGL-2537 (V_8) and MTU-1124 (V_6). While, the Uptake of N was the lowest with MTU-1121(V_4) which was however, found on a par to BPT-5204 (V_2).The differences in N uptake among the varieties may be attributed to genetic factors, as different rice varieties can have varying abilities 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 plant's 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 (Jahan *et al.*, 2022).

Table 2. Nitrogen uptake (Kg ha^{-1}) as influenced by age of seedlings and varieties

Treatments	Flowering	Grain	Straw
Age of seedling(A)			
A_1 : 30 days	93.13	73.35	81.15
A_2 : 45 days	90.57	69.33	74.57
A_3 : 60 days	82.12	61.49	67.56
SEm (±)	1.48	0.93	1.03
CD (P=0.05)	5.83	3.64	4.03
CV (%)	8.20	6.67	6.76
Variety (V)			
V_1 : MTU-7029	85.70	64.15	71.35
V_2 :BPT-5204	81.45	63.11	70.00
V_3 :MTU-1061	89.77	67.28	76.17
V_4 :MTU-1121	73.95	56.32	63.88
V_5 :MTU-1223	98.75	77.69	81.78
V_6 :MTU-1224	93.38	71.68	77.36
V_7 :MTU-1262	90.89	70.81	76.69
V_8 :RGL-2537	94.95	73.39	78.19
SEm (±)	2.68	1.19	1.69
CD (P=0.05)	7.65	3.40	4.82
CV (%)	9.08	5.25	6.81
Interaction			
SEm (±)	**4.64**	**2.06**	**2.93**
CD (P=0.05)	**NS**	**NS**	**NS**

Phosphorous uptake (kg ha^{-1}):

Table 3. Phosphorous uptake (kg ha^{-1}) as influenced by age of seedlings and varieties.

Treatments	Flowering	Grain	Straw
Age of seedling(A)			
A_1 : 30 days	23.48	19.16	13.88
A_2 : 45 days	22.73	17.32	12.80
A_3 : 60 days	21.58	15.19	11.62
SEm (±)	0.28	0.34	0.40
CD (P=0.05)	1.10	1.32	1.57
CV (%)	6.06	9.59	15.38
Variety (V)			
V_1 : MTU-7029	21.28	16.39	11.53
V_2 :BPT-5204	20.55	15.83	11.37
V_3 :MTU-1061	22.59	16.68	12.32
V_4 :MTU-1121	19.67	15.20	11.23
V_5 :MTU-1223	24.98	19.97	14.87
V_6 :MTU-1224	23.71	17.91	13.70
V_7 :MTU-1262	23.26	17.55	13.20
V_8 :RGL-2537	24.74	18.27	13.93
SEm (±)	0.58	0.59	0.40
CD (P=0.05)	1.65	1.68	1.14
CV (%)	7.70	10.23	9.36
Interaction			
SEm (±)	**1.00**	**1.02**	**0.69**
CD (P=0.05)	**NS**	**NS**	**NS**

Phosphorous uptake of rice computed at various growth stages *viz.*, flowering and maturity (by grain and straw) are presented in table 3. Statistically measurable disparities were noticed in Phosphorous uptake of rice due to age of nursery at transplanting and different varieties tried. However, the interaction affect between the age of nursery and varieties with respect to phosphorous uptake was not statistically detectable.

Significantly higher values for phosphorous uptake by rice at flowering, by grain and by straw were noticed when rice seedlings were transplanted at 30 days age (A_1), which was however on par with 45 days age (A_2), while it was the lowest with 60 days old seedlings (A_3). This was due to better absorption and translocation of nutrients in 30 day old seedlings as compared to 45 and 60 day old seedlings. Similar results were reported byPradhan *et al*. (2021).

With regards to influence of varieties on phosphorous uptake by rice by rice at flowering, by grain and by straw, marked differences were observed among the varieties tested. Phosphorous uptake was found to be the highest with MTU-1223 (V_5) which was however, comparable with MTU-1224, RGL-2537 (V_8) and MTU-1224 (V_6). Significantly lower values for phosphorous uptake were observed in MTU-1121 (V_4) which was however, statistically comparable with BPT-5204 (V_2) and MTU-7029 (V_1). The differences in nutrient absorption and their yield potential among varieties might be the reason. Ju *et al*. (2021) also reported similar findings with varieties and P uptake.

Potassium uptake (kg ha^{-1})

Significant variations in the uptake of potassium at flowering as well as by grain and straw of rice were noticed due to age of seedlings at transplanting and varieties (table 4). However, the interaction effect between these two factors was not statistically traceable.

Significantly higher potassium uptake was noticed by rice at flowering, by grain and by straw when rice seedlings were transplanted at 30 days age (A_1), which was however on par with 45 days aged seedlings (A_2), while it was the lowest with 60 days old seedlings (A_3).

With regards to the influence of varieties on potassium uptake the highest potassium uptake was found byrice at flowering with MTU-1223 (V_5). Significantly lower values of potassium uptake was observed with MTU-1121 (V_4) which was however, statistically comparable with BPT-5204 (V_2), MTU-1061(V_3), MTU-1224(V_6), MTU-1262 (V_7), MTU-7029 (V_1) and RGL-2537(V_8).

Table 4. Pottassium uptake(kg ha^{-1}) as influenced by age of seedlings and varieties

Treatments	Flowering	Grain	Straw
Age of seedling(A)			
A_1 : 30 days	71.14	42.65	125.20
A_2 : 45 days	69.36	39.92	122.08
A_3 : 60 days	64.34	33.47	113.25
SEm (±)	1.08	0.86	1.91
CD (P=0.05)	4.26	3.40	7.49
CV (%)	7.78	10.95	7.78
Variety (V)			
V_1 : MTU-7029	66.67	36.53	117.33
V_2 :BPT-5204	66.25	35.10	116.60
V_3 :MTU-1061	67.17	37.29	118.21
V_4 :MTU-1121	65.67	33.49	115.57
V_5 :MTU-1223	75.78	45.72	133.37
V_6 :MTU-1224	67.92	40.45	119.53
V_7 :MTU-1262	67.50	39.51	118.80
V_8 :RGL-2537	69.31	41.36	121.98
SEm (±)	1.97	1.51	3.47
CD (P=0.05)	5.63	4.30	9.91
CV (%)	8.67	11.68	8.67
Interaction			
SEm (±)	**3.42**	**2.61**	**6.01**
CD (P=0.05)	**NS**	**NS**	**NS**

Potassium uptake by grain exerted statistically measurable influence among different varieties. Potassium uptake was found to be the highest with V_5 (MTU-1223) and lowest with V_4(MTU-1121) which was however, comparable with V_2 (BPT-5204), V_3 (MTU-1061) and V_1 (MTU-7029).

Potassium uptake of by rice straw was found to be the highest with MTU-1223 (V_5). Significantly lesser potassium uptake was observed with V_4 (MTU-1121) which was however, found statistical parity with V_2 (BPT-5204), V_3 (MTU-1061), V_6 (MTU-1224), V_7 (MTU-1262), V_1 (MTU-7029) and V_8 (RGL-2537).

Conclusion:

Among the threeage of seedlings for transplanting, planting of 30 days seedlings (A_1) proved superior by recording higher growth parameters and yield structure, yield and economic returns, pest and disease incidence compared to planting of 45 days (A_2) and 60 days old seedlings (A_3). Among the varieties tested, the higher grain yield,straw yield and nutrient uptake was noticed with MTU-1223 (V_5) followed by MTU-1224 (V_6) and RGL-2537 (V_8). Whereas, the lowest grain yield, straw yield and economic returns was associated with MTU-1121 (V_4) which was however, comparable with BPT-5204 (V_2).Profit of Rs 17190/- was the difference between the maximum and minimum among the varieties tested. Further the study can be concluded as decline in yield and returns are certain with increasing age of seedlings in rice, however by choosing varieties Viz., MTU-1223 (V_5), MTU-1224 (V_6), MTU-1262 (V_7) and MTU-1061 (V_3) when 45 days old seedlings (A_2) transplanted and RGL-2537 (V_8) and MTU-1223 (V_5) when 60 days old seedlings (A_3) needs to be transplanted the yield and profit loss can be minimized noticeably.

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