Eco. Env. & Cons. 29 (4) : 2023; pp. (1700-1703)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2023.v29i04.039

Assessing the Impact of Seedling Age and Number in Enhancing Rice (*Oryza sativa* L.) Growth and Yield Performance under Delayed Transplanting Conditions

Indrani Debasmita Borah[1*], Aditya K. Singh[2], Shibani Ritusmita Borah[3], Okram Ricky Devi[4], Bibek Laishram[5], Akarsha Raj[6] and Shubham Singh[7]

[1,4,5] Department of Agronomy, Assam Agricultural University, Jorhat, Assam, 785013,
[2]School of Natural Resource Management, CPGS-AS (Central Agricultural University, Imphal), Imphal 793 103, Meghalaya, India
[3]Department of Plant Breeding and Genetics, Assam Agricultural University, Jorhat 785 013, Assam, India
[6]Department of Agronomy, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India
[7]Department of Agronomy, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

(Received 17 April, 2023; Accepted 23 June, 2023)

ABSTRACT

The experiment's findings demonstrated that seedlings of 40 days old and planted in groups of four established themselves well and grew more swiftly than seedlings of other ages and numbers. This is probably due to improved LAI efficiency and higher tillers, which allowed for the retention of more plants till harvest, increasing plant dry weight, hence, consequently resulted in much greater yield.

Key words: *Seedling Age, Delayed Transplanting, Oryza sativa*

Introduction

The fact that 60% of the world's population depends on rice (*Oryza sativa* L.) as a staple grain has a substantial impact on global food security.The rapid upsurge of the world's population demands 25% more rice production from 2001 to 2025, posing a great challenge to meeting the demand in a sustainable way. In the rice fields, a delay in transplanting is frequently experienced where transplanting is a typical crop establishment technique because of an uncertain water supply, erratic monsoonal rainfall especially in lowlands with unfavourable rainfed conditions or unanticipated circumstances like the COVID-19 pandemic in which several countries were experiencing a labour shortage in the agricultural sector, particularly in those with high seasonal labour demand due to lockdowns and restrictions on people's movement during pandemic. These factors either caused the seedlings to spend more time in the nurserybed or cause seedling transplantation to be delayed. The ideal temperature range for rice cultivation is 25°C to 35°C, of which 25–31°C is needed for tillering, 30-33°C and 20–29°C are needed for anthesis and ripening, respectively. The delay in transplanting leads to low temperature

([1,4,5] Ph.D Scholar, [2]Assistant Professor (Agronomy), [3]Ph.D Scholar, [6]Ph.D Scholar, [7]Ph.D Scholar) stress during the vegetative period might inhibit growth and weaken seedlings vigour (Ali *et al*., 2006), minimal tillering (Shimono *et al*., 2002), rising plant mortality, extend the time for growth and it can result in panicle sterility during the reproductive stage, which lowers grain yield and productivity (Baruah *et al*., 2009). Despite these limitations, rice production must increase over the next generation to satisfy global food security. Therefore, we require new crop production strategies that are practical, cost-effective and demand-drivenlow inputs such as the number of seedlings per hill and the age of transplanted seedlings, as they are affordable and farmers may readily use them without having to change their input requirements. Keeping view of the above, a field experiment was carried out to find the correct age and number of seedlings to be transplanted into each hill under delayed transplanting conditions.

Materials and Methods

The experiment was conducted at the CPGS-AS (CAU-Imphal), Umiam (Meghalaya). The experimental site experiences humid sub-tropical climates with cold winters and high rainfall located in North-Eastern Hill region of India (25.67°N latitude, 91.92°E longitudes with an altitude of 950 m above mean sea level). Treatment wise seeds of medium duration rice cultivar CAUS107 were sown on a nursery bed on different dates (20th June, 30thJune and 10th July 2021) and in the main rice field, seedlings were transplanted on 10th of August 2021 at 20 cm x15 cm with one, two, three and four seedlings hill^{-1} as per the treatment combinations in factorial randomized block design and replicated thrice. During the crop growth period, the total rainfall, weekly average maximum and minimum temperature and relative humidity were 1165.6 mm, 8.79 ^{o}C and 33.64 ^{o}C, 67.71% and 91.69%. The crop was grown as per the recommended packages and practices of the region, except for the treatment. The experimental data were subjected to statistical analysis using analyses of variance technique for FRB design as recommended by Gomez and Gomez (1984) and treatment means were compared at a 5% level of probability (p=0.05).

Results and Discussion

Growth parameters: Data related to growth parameters of rice as influenced by age and number of seedlings hill^{-1} at harvest except for LAI which measured at 90 days after transplanting, are presented in Table 1. The findings indicated thattransplanting of 40 days old being at par with 50 days old seedlings, showed a significantly moreleaf-area index, dry matter accumulation and root dry weight over the 30 days old seedlings. The plant height and root: shoot ratio did not vary significantlydue to seedling age. The non-significant variation in heightmight be due to the genetic makeup of the plant (Zhang *et al*., 2004). The possible attributed explanation for high values of growth parameters of 40 days old seedlings at maturity can be linked to the cumulative effects of high degree of root activity and photosyn-

Table 1. Influence of age and number of seedlings on growth parameters of rice

Treatments	Plant height (cm)	LAI at 90 DAT	Plant dry weight (g hill^{-1})	Root dry weight (g)	Root: Shoot ratio
Age of seedlings					
A_1	100.8	5.13	44.50	3.76	0.085
A_2	99.1	5.57	48.24	4.26	0.089
A_3	101.7	4.73	43.40	3.50	0.081
S.Em±	2.946	0.2	1.37	0.13	0.004
CD(p=0.05)	NS	0.6	4.01	0.38	NS
Number of seedlings hill^{-1}					
N_1	100.5	3.98	40.36	3.52	0.087
N_2	100.9	5.32	45.31	3.74	0.083
N_3	100.9	5.79	47.67	3.93	0.082
N_4	99.93	5.48	48.19	4.17	0.087
S.Em±	3.402	0.24	1.58	0.15	0.004
CD(p=0.05)	NS	0.69	4.63	0.44	NS

A1: 50 days old seedlings, A2: 40 days old seedlings, A3: 30 days old seedlings, N1: one seedling hill-1, N_2: two seedlings hill^{-1}, N_3: three seedlings hill^{-1}, N_4: four seedlings hill^{-1}

thetic activity that cause more numbers of tillers, higher LAI and more dry matter accumulation because they suffer less root damage during uprooting and mortality rate (Imran *et al.,* 2015). Persistence of a greater number of tiller hills^{-1}, a larger leaf area, more panicles, and filled grains that remained until maturity resulted in higher plant dry weight. The low minimum temperature stress that persisted throughout the crop cycle and the very heavy rainfall that occurred just a few days after transplanting caused poor crop establishment, which in turn caused decreased root activity leading toshallow root system which discourages tillering (Patra and Hoque, 2011) and production of secondary and tertiary tillers in the main field by low aged tillers which are incapable for production of panicle, leading to low plant dry weight (Faruk, 2009). These factors negatively impacted nutrient uptake from the soil, hence could be blamed for high mortality of tillers.

Similarly, among various seedling numbers hill^{-1}, significantly the highest value of LAI, total plant dry weight as well as root dry weight were recorded when transplanting was done with four numbers of seedlings in a hill, which was statistically at par with three seedlings hill^{-1} in the case of plant and root dry weight, while plant height and root:shoot ratio were influenced non-significantly. However, transplanting one seedling hill^{-1} produced significantly lower growth attributes in the study which could be attributed to significantly less leaf area available for absorption of solar radiation as evidenced by lesser number of tillers hill^{-1}, low crop growth rate. The findings of Alam *et al.* (2012) and Damodaran *et al*. (2012) supported this conclusion.

Yield attributes: The results (Table 2) revealed significantly higher values of plant population at harvest, total numbers of grains panicle^{-1}, grain weight hill^{-1} as well as grain and biological yield were observed in 40 days old seedlings hill^{-1} over the 30 and 50 days old seedlings, while it had no significant impact on panicle per hill^{-1} and test weight.The reason might be due to thegreater values of growth characters (higher leaf area index leading to more dry matter production) as well as greater root development as evidenced byplant and root dry weight and balanced nutrient availability and favourable conditions for uptake throughout the crop growth. At the full heading stage, the rice's accumulation of carbohydrates, nitrogen, and dry matter peaked. At the heading stage of a 40-day-old seedling, the productive tillers m^{-2} and panicle number unit area^{-1} displayed an increasing trend, and sink demand for source assimilate was increased. This may have been the primary factor in the higher assimilation and translocation percentage, which led to the production of more numbers of filled grains, ultimately leading to high grain and biological yield. The reduced yield in 30 days old seedlings over 40 days old seedlings was due to lower values of yield at-

Table 2. Influence of age and number of seedlings on yield attributes and yield of rice at harvest

Treatments	Plant population at harvest (lakh ha^{-1})	Panicle hill^{-1}	Number of grains panicle^{-1}	Test weight (g)	Grain weight (g hill^{-1})	Grain yield (t ha^{-1})	Biological yield (t ha^{-1})
Age of seedlings							
A_1	2.51	11.22	152.64	22.68	23.82	2.07	8.26
A_2	2.59	11.25	175.21	22.85	25.25	2.41	10.12
A_3	2.3	11.20	146.72	22.12	19.70	1.88	8.03
S.Em±	0.08	0.39	5.25	0.66	0.90	0.06	0.30
CD(p=0.05)	0.23	NS	15.39	NS	2.64	0.17	0.88
Number of seedlings hill^{-1}							
N_1	2.3	9.60	145.93	22.05	17.57	1.78	6.77
N_2	2.43	10.45	154.59	22.80	20.15	1.94	8.64
N_3	2.57	11.30	160.72	22.86	26.44	2.30	9.25
N_4	2.62	13.55	171.52	22.48	27.53	2.46	10.55
S.Em±	0.1	0.45	6.06	0.76	1.04	0.07	0.35
CD(p=0.05)	NS	1.32	17.78	NS	3.05	0.19	1.02

A1: 50 days old seedlings, A2: 40 days old seedlings, A3: 30 days old seedlings, N1: one seedling hill-1, N_2: two seedlings hill^{-1}, N_3: three seedlings hill^{-1}, N_4: four seedlings hill^{-1}

tributes studied which ultimately led to poor grain yields (Gurjar *et al.*, 2017)

Thefour seedlings hill^{-1} recorded the maximum numbers of panicle hill^{-1}, numbers of grains panicle^{-1}, grain weight hill^{-1}, grain yield and biological yield, which were significantly highest over one seedling hill^{-1} and statistically at par with three seedlings hill^{-1} in case of numbers of grains panicle^{-1}, grain weight hill^{-1} and grain yield. This could be as a result of more productive tillers yielding more grains. The more plants that are present in a hill, along with more root growth, which results in higher soil nutrient uptake and, eventually, better growth, might be the reason for higher yield and yield attributing characters. Whereas one seedling might not be able to establish well under delayed transplanting conditions with the submerged situation which leads to more mortality rateand hence leads to low yield and yield attributing characters. The Liu *et al*. (2017) observed similar conclusion.

When transplanting was delayed, 40 days old seedlings significantly performed best over the other two seedling ages in terms of growth and yield attributes. With the 40 days old medium-duration variety, planting could be postponed until August 10th. Hence, the research concluded that 40 days old seedlings and if transplanted with four seedlings in each hill will be an effective strategy to make up for expected yield loss due to delayed rice transplanting. Different seedlings ages more than a month may be evaluated further having good tolerance to low temperatures and heavy rainfall during reproductive and grain filling periods for their suitability as an alternative to delayed rice transplanting in many unforeseen circumstances. Additionally, experiments involving the transplanting of mature seedlings with different seedling densities or bunch transplanting may be carried out to guarantee the necessary plant population at harvest in swampy lowland areas that frequently receive heavy to extremely heavy rainfall and have limited drainage opportunities.

Conclusion

The experiment's findings demonstrated that seedlings of 40 days old and planted in groups of four established themselves well and grew more swiftly than seedlings of other ages and numbers. This is probably due to improved LAI efficiency and higher tillers, which allowed for the retention of more plants till harvest, increasing plant dry weight, hence, consequently resulted in much greater yield.

References

Alam, M.S., Baki, M.A., Sultana, M.S., Ali, K.J. and Islam, M.S. 2012. Effect of variety, spacing and number of seedlings hill-1 on the yield potentials of transplant Aman rice. *Int. J. Agron. Agric. Res.* 2(12): 10-15.

Ali, M.G., Naylor, R.E.L. and Matthews, S. 2006. Distinguishing the effects of genotype and seed physiological age on low temperature tolerance of rice (*Oryza sativa* L.). *Exp. Agric.* 42(3): 337- 349.

Baruah, A.R., Ishigo-Oka, N. and Adachi, M. 2009. Cold tolerance at the early growth stage in wild and cultivated rice. *Euphytica.* 165(3): 459-470.

Damodaran, V., Saren, B.K., Ravisankar, N. and Bommayasamy, N. 2012. Influence of time of planting, spacing, seedling number and nitrogen management practices on productivity, profitability and energetic of rice in Island ecosystem. *Madras Agric. J.* 99 (7-9): 538-544.

Faruk, M.O., Rahman, M.A. and Hasan, M.A. 2009. Effect of seedling age and number of seedlings per hill on the yield and yield contributing characters of BRRI Dhan 33. *Int. J. Sustain. Crop Prod.* 4 (1): 58-61.

Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedures for Agricultural Research. 2nd edn. Willey Int. Sci. Publ., New York. 324.

Gurjar, G.N. 2017. Effect of age of seedlings and number of seedlings per hill on growth and yield of Manipur black scented rice (*Oryza sativa* L.) cv. chakhaopoireiton. *Int. J. Agric. Sci.* 9(25): 4311-4314.

Imran, A.A.K., Shah, F.A., Inamullah, L.Z., Muhammad, N. and Khan, N. 2015. Phenological traits of rice as influenced by seedling age and number of seedling per hill under temperate region. *J. Biol. Agric.* 5 (3): 145-149.

Liu, Q., Zhou, X., Li, J. and Xin, C. 2017. Effects of seedling age and cultivation density on agronomic characteristics and grain yield of mechanically transplanted rice. *Sci. Rep.* 7(1): 1-10.

Patra, P.S. and Haque, S. 2011. Effect of seedling age on tillering pattern and yield of rice (*Oryza sativa* L.) under system of rice intensification. *Asian Res. Pub. Net. J. Agric. Biol. Sci.* 6 (11): 33-35.

Shimono, H., Hasegawa, T. and Iwama, K. 2002. Response of growth and grain yield in paddy rice to cool water at different growth stages. *Field Crops Res.* 73 (2/3): 67-79.

Zhang, P.J., Zhan, X.C., Zhang, M., Jiang, F.J. and Li, A. 2004. Effect of transplanting densities and seedling number hill-1 on yield of medium Japonica hybrid rice. *Hybrid Rice.* 19(1): 43-44.