Original Research Article

Response of varying seedling age, transplanting time and foliar supplements on growth and development of rice

Abstract

In India rice is mostly grown through transplanting method. Sometimes, transplanting is delayed due to late onset of the monsoon, lack of irrigation facility and labour scarcity which ultimately affect physiological growth and yield of rice crop. For managing this situation foliar spray at vegetative and reproductive stage may be an option to increase plant growth and productivity. Therefore, an experiment was planned during *Kharif* season 2022 and 2023 at N.E. Bourlag Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand to find out response of seedling age, transplanting time and foliar nutrition on dry matter accumulation, plant height, crop growth rate and relative growth rate of rice. The experiment was laid out in split plot design with three replications. The experiment consisted of five treatments in main plot viz., N1: 25 days nursery transplanting on 25 June, N2: 25 days nursery transplanting on 2 July, N3: 32 days nursery transplanting 2 July, N4: 25 days nursery transplanting on 9 July and N5: 39 days nursery transplanting on 9 July and three foliar treatments in sub plot F0:control, F1: foliar spray of urea 2 % at active tillering stage followed by spray of MOP 1% at panicle emergence stage and F2: foliar spray of NPK 2 % at active tillering followed by spray of KNO_3 1% at panicle emergence stage. Results of present study revealed that varying seedling age and transplanting time significantly influenced plant height, dry matter accumulation, CGR and RGR of rice. The maximum dry matter accumulation and growth was recorded in 25 days nursery transplanting 25 June(N1) treatment which was at par with 25 days nursery transplanting on 2 July(N2). The reduction in dry matter and growth was recorded with 39 days nursery transplanting on 9 July(N5) and 25 days nursery transplanting on 9 July (N4) treatments. Among foliar treatments, foliar supplements significantly improved growth parameters of rice as compared to control.

Key words: Rice, seedling age, transplanting time, dry matter accumulation, plant height, CGR, RGR, foliar supplements.

Introduction

Rice cultivation in India is predominantly practiced by transplanting method. Among various aspects of growing better crop quality; age of seedlings in relation to transplanting time is of utmost significance. Usually 22-25 days seedling age of rice is preferred for transplanting under normal growing condition. Now a days, delay onset of monsoon, less water avabilibity and scarcity of labour are major reasons for late transplanting and farmers are forced to transplant aged seedling. Mobasser *et al*. (2007) observed that when seedlings stay for a longer period of time in the nursery beds, primary tiller buds on the lower nodes of the main culm become degenerated leading to reduced tiller production. Contrary to this, Liu *et al*. (2017) reported that the younger seedling stays in the nursery bed for a short period and thus nodes are not formed and they quickly recover the transplanting shock in the main field. Use of older age seedlings significantly affect rice growth, tillering pattern causing short vegetative and reproductive period of crop, lower dry matter accumulation and thus has detrimental impacts on grain yield. Sowing date is pivotal for optimum rate of establishment and subsequent phenology for growth and development. Delaying in sowing also reduces the time for maximum tillering i.e. the vegetative period and thus the number of productive tillers. (Roy *et al*., 2018). Seedling age and transplanting time both are important for maximizing productivity and profitability of rice. For managing both the situation, foliar spray at vegetative and reproductive stage may be an alternative to increase plant growth and productivity. Therefore, an experiment was planned during *Kharif* season 2022 and 2023 at N.E. Bourlag Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand to find out response of seedling age, transplanting time and foliar nutrition on dry matter accumulation, plant height, crop growth rate and relative growth rate of rice.

Material and method

The field experiment was conducted in at Norman E. Borlaug Crop Research Centre of G. B. Pant University of Agriculture and Technology, Pantnagar, (Udham Singh Nagar), Uttarakhand during *Kharif* season of 2023.The total rainfall occurred at Pantnagar (Uttarakhand) during the crop season (June to October) was 1157.9 mm and 1427.6 mm in 2022 and 2023 respectively. The maximum rainfall occurred during July to September was 65.5% and 91.1% of total rainfall in 2022 and 2023 respectively. soil of the experimental plot was low in available N, medium in organic carbon, medium in available phosphorus and potassium and neutral to slightly alkaline in reaction. In this experiment, 15 treatment combinations were tested in Split Plot Design with three replications. In main plot 5 treatment 25 days nursery transplanting on 25 June(N1) ,25 days nursery transplanting on 2 July(N2), 32 days nursery transplanting on 2 July(N3), 25 days nursery transplanting on 9 July(N4) and 39 days nursery transplanting on 9 July(N5) and sub plot 3,Control-no spray(F0), 2% urea at active tillering and 1% MOP at 80% panicle emergence(F2) and 2% NPK at active tillering and 1% KNO3 at 80% panicle emergence(F3). PR121, medium duration varieties was taken for experiment and transplanted at 20 ×20 cm spacing with one seedling per hill. The recommended dose of fertilizer was 150:60:40 kg N: P_2O_5:K_2O ha^{-1} and the sources were NPK(12:32:16), Urea and Muriate of Potash were applied. Following data were taken growth and harvest stage.

Plant height

To measure all the growth parameters two border rows from each side and 0.5m was left for each plot. The growth parameters was recorded from marked sample area in each plot. The plant height was measured on six tagged hills located at four corners of the individual plot. The height of the individual hill was measured with the help of a meter scale from the base of the plant to the upper most tip of the tallest leaf before the emergence of panicle and from ground level to the tip of panicle after the emergence of panicle. The plant height was taken at 30, 60, 90 and at harvest.

Dry matter accumulation

Sample for dry matter accumulation was collected from four hills at 30, 60, 90 days after transplanting and at harvest. The crop samples was clipped close to the ground and collected in polythene bags. Then plant washed with water and kept in paper bags and dried in hot air oven maintained at 70±2°C temperature until the weight became constant. After drying, the weight was recorded and expressed as g m^{-2}.

Crop growth rate

To measure crop growth rate (CGR), the dry matter of crop was taken at 30, 60, 90 DAS and at maturity and CGR was calculated by adopting the following formula given by Watson *et al.* (1952). It is expressed as g of dry matter produced per day (g day^{-1}).

$$\mathrm{CGR} = \frac{W_2 - W_1}{T_2 - T_1}$$

Where, W_1 and W_2 are dry weights (g) of plants at time T_1 and T_2, respectively.

Relative growth rate

Relative growth rate (RGR) indicates rate of growth per unit dry matter and dry matter produced by existing dry matter in a day (g g^{-1} day^{-1}).

$$\mathrm{RGR} = \frac{\log_e W2 - \log_e W_1}{T_2 - T_1}$$

Where, W_1 and W_2 are dry matter at time T_1 and T_2, respectively.

Result and Discussion

Plant height

The height of rice plant increased progressively as the age of crop advanced. It is also very much clear from Table1 that more than 75 per cent plant height of rice crop attained by 60 DAT in all the treatments. Significant effect of seedling age and transplanting time on plant height was noticed at 30, 60 and 90 DAT but, at maturity, it was found non-significant in this regard.

At 30 DAT, the highest plant height was observed with 39 days nursery transplanting on 9 July, which was at par with 25 days nursery transplanting on 9 July treatments. At 60 days after transplanting, the highest plant height was observed with 39 days nursery transplanting on 9 July, which was significantly higher over rest of the treatments, at 90 DAT, Plant height was significant higher in 25 days nursery transplanting on 25 June, which was statically superior to 25 days nursery transplanting on 9 July and 39 days nursery transplanting on 9 July but at par with rest of the treatments. It was stated that the increased in plant height due to transplanting of young seedlings could be due to less root damage during uprooting, as their root length was shorter than that of older ones. The young seedling resulted in full utilization of the root structure in absorption of nutrients and their upward flow which perhaps produced vigorous plants at later growth stages. transplanting young rice seedlings reduces the transplanting shock and favours early root establishment and growth Contrary to this, older seedlings might have utilized their stored carbohydrates for repairing damaged roots in early growth stages, so their percent increase in plant length was slower than that of the younger ones. The young seedlings found to have with better root growth that facilitated increased cell division and cell enlargement due to increased photosynthetic rate which subsequently increased the plant height soil as indicated by Shrirame *et al*. (2000), Rahman *et al*. (2013), Kirttania *et al*. (2013) and Rasool *et al*. (2016).

In the present investigation at maturity, the maximum plant height was recorded in 25 days nursery transplanting on 25 June and minimum was recorded in 39 days nursery transplanting on 9 July. However, the differences were non-significant. For late transplanting, a reduction in plant height may also be related to low temperatures and less sunshine hours towards maturity (Ashraf *et al*. 2014). One of the reasons for increased plant height in earlier transplanting dates may be the availability of prolonged period for vegetative growth. However, a positive and linear effect of nitrogen on plant height and panicle length had been observed which confirmed the encouraging role of nitrogen in rice development and biomass accumulation. Our results are supported by the findings of Safdar *et al*. (2008) and Akram *et al*. (2007) who found that early transplanting of rice results in better growth compared with late transplanting.

The different foliar supplement has significant effect on plant height at 60, 90 and maturity of crop over control treatment. Foliar application of 2% NPK at active tillering followed by 1% KNO_3 at 80% panicle emergence recorded maximum plant height at all the growth stages except 30 DAT. which was significantly superior to control treatment where as at par with foliar application of 2% Urea at active tillering followed by 1% MOP at 80% panicle emergence. The foliar spray of major nutrients might have increased plant height favourably due to their role in increased cell division, cell elongation and increased photosynthetic rate. Potassium spray might have resulted in attaining balanced nutrition and sugar translocation in plant and helped in maintaining the turgor pressure of the plant cells thereby increasing meristematic activity for better growth and development of the crop. Similar findings were observed by Bowmick *et al*. (2008) and Premsekhar and Rajashree (2009). One of the reasons for increased plant height in earlier transplanting dates may be the availability of prolonged period for vegetative growth. However, a positive and linear effect of nitrogen on plant height and panicle length had been observed which confirmed the encouraging role of nitrogen in rice development and biomass accumulation. Our results are supported by the findings of Safdar *et al*. (2008) and Akram *et al*. (2007) who found that early transplanting of rice results in better growth compared with late transplanting.

Dry matter accumulation

Dry matter accumulation directly reflecting the plant's growth and metabolic efficiency, essentially acting as a key indicator of potential yield as more dry matter accumulated throughout the growth stages leads to a higher rice harvest. In the present study, dry matter was also significantly affected by seedling age and transplanting time at all the growth stage except at 90 days after transplanting time.

At 30 DAT the significantly higher dry matter accumulation was recorded in 25 days nursery transplanting on 9 July, which was at par with 25 days nursery transplanting on 2 July. At 60 DAT, highest dry matter was observed with 39 days nursery transplanting on 9 July, which was significantly higher to rest of the treatments. At 90 DAT, the maximum dry matter accumulation was recorded in 32 days transplanting on 2 July and minimum was recorded in 39 days nursery transplanting on 9 July, however, the differences were non-significant. At maturity, it was highest in 25 days nursery transplanting on 25 June but it was at par with 32 days nursery transplanting on 2 July and 25 days nursery transplanting on 2 July. The lowest dry matter was recorded with 39 days nursery transplanting on 9 July. The total dry matter production in a plant often indicates its potentiality for yield but its mobilization toward grain development is important for higher yield. In the present study younger seedling had got an advantage of having quick establishment, robust root growth, more nutrients absorption and greater leaf area which resulted in higher plant dry matter accumulation. This was in the agreement with Khakwani *et al*. (2005). Mishra and Salokhe (2008) reported that the increase in dry matter production in younger seedling could be due to the early phyllochron stage and less root damage during uprooting as root length was less than that of older one. Sahoo *et al*. (2004) reported that planting of younger seedling recorded greater shoot dry matter than that of older seedlings is attributed to faster recovery from transplanting shock, production of healthy plants with more number of tillers. For late transplanting, a reduction in dry matter may also be related to very vegetative growth period, low temperatures and less sunshine hours towards maturity.

Foliar nutrients were applied at active tillering stage and 80% panicle emergence stage. Therefore, response of foliar nutrients was significant at later stages of growth where as at early stage it was found non-significant. Foliar application of 2% NPK followed by 1% KNO_3 recorded maximum dry matter which was significantly superior to control treatment but was at par with foliar application of 2% Urea followed by 1% MOP at 60, 90 days after transplanting and at maturity. Foliar application of nitrogen (e.g., urea or nitrate-based fertilizers) at the tillering stage stimulates chlorophyll synthesis and photosynthetic activity. This leads to increased carbohydrate production and biomass accumulation, providing the energy required for tiller growth and development. (Singh *et al*., 2018). Studies by Zhang *et al*. (2016) found that foliar application of potassium nitrate during the reproductive phase increased grain weight and improved grain quality.

Table 1: Effect of seedling age, transplanting time and foliar nutrition on plant height and dry matter accumulation with pooled data of 2022 and 2023

Treatment	Plant height (cm)				Dry matter accumulation (gm^{-2})			
	30 DAT	60 DAT	90 DAT	at maturity	30 DAT	60 DAT	90 DAT	at maturity
Seedling age and transplanting time								
N1: 25 DN*, 25 June Transplanting	49.0	87.4	108.8	109.1	104	608	1243	1336
N2: 25 DN, 2 July Transplanting	54.2	87.4	108.0	108.3	111	586	1150	1271
N3: 25 DN, 2 July Transplanting	51.4	88.0	106.6	106.8	102	588	1244	1292
N4: 25 DN, 9 July Transplanting	60.8	85.3	104.3	104.6	122	600	1177	1253
N5: 25 DN, 9 July Transplanting	59.2	91.6	104.5	104.7	104	690	1147	1162
SEm±	**1.2**	**1.0**	**0.9**	**1.5**	**3**	**19**	**31**	**25**
CD at 5%	**3.9**	**3.3**	**2.9**	**NS**	**11**	**62**	**NS**	**81**
Foliar nutrition								
F0: Control (no spray)	54.6	86.9	105.1	104.1	108	582	1119	1196
F1: 2% urea *fb* 1% MOP	54.7	88.2	106.6	104.9	109	625	1210	1280
F2: 2% NPK** *fb* 1% KNO3	55.6	88.9	107.6	105.8	109	647	1248	1313
SEm±	**0.6**	**0.4**	**0.5**	**0.4**	**3**	**16**	**21**	**25**
CD at 5%	**NS**	**1.2**	**1.6**	**1.1**	**NS**	**47**	**62**	**73**

* DN -Days nursery and **NPK-water soluble (19:19:19)

Crop growth rate

Irrespective of the seedling age and transplanting time, there was an increase in the CGR values till 60-90 DAS, which declined thereafter, during 90-120 DAS. Between 30-60 DAT, higher CGR was recorded with 39 days nursery transplanting on 2 July, which was higher then rest of treatment. At 60-90 DAT, significantly higher CGR noticed with 25 days nursery transplanting 25 June. At 90-120 DAT, CGR was lowered as seedling age increased, and significantly higher with 25 days nursery transplanting on 25 June and lowest in 39 days nursery transplanting on 9 July. Among the foliar supplements, foliar nutrition had significant impact till 30-60 DAT, thereafter non-significant impact during 60-90 DAT and 90-120 DAT. At 30-60 DAT, highest CGR recorded with 2% NPK at active tillering followed by 1% KNO_3 which was at par 2% urea followed by 1% MOP.

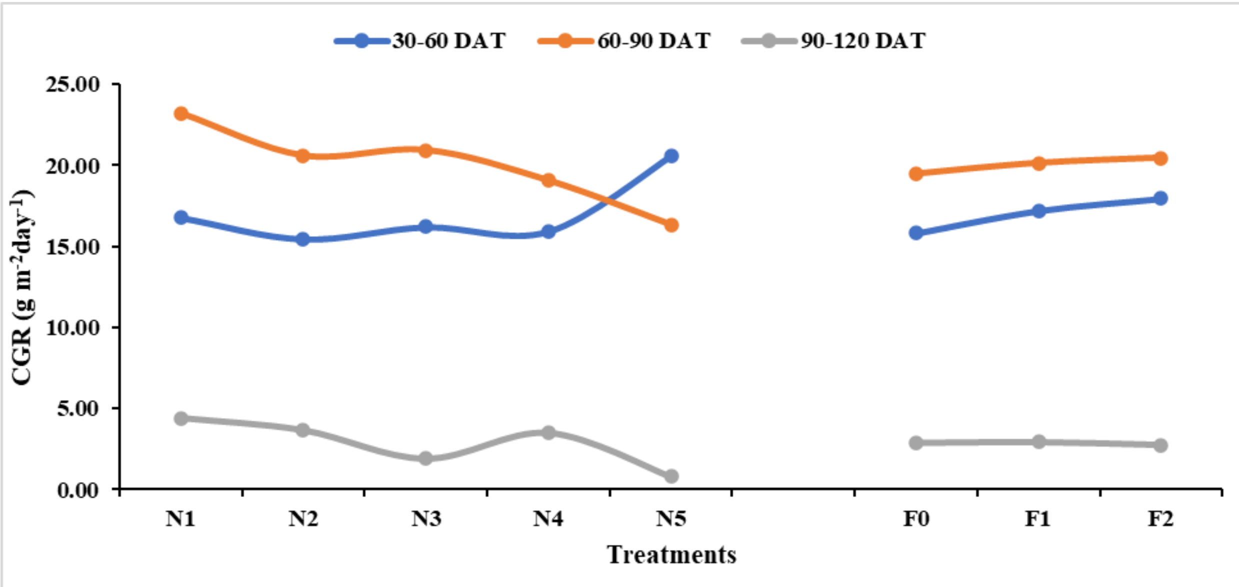

Fig.1. Effect of seedling age, transplanting time and foliar nutrition on crop growth rate

Relative growth rate

Unlike CGR, RGR has seen initially higher values between 30-60 DAT, which had further declined between 60-90 DAT and then between 90-120 DAT. Between 30-60 DAT, RGR values were significantly higher with 39 days nursery transplanting on 9 July, which was at par with 25 days nursery transplanting on 25 June and 32 days nursery transplanting on 2 July At 60-90 DAT, maximum RGR noticed with 32 days nursery transplanting on 2 July which was at par with of treatment except 39 days nursery transplanting on 9 July. At 90-120 DAT, significantly higher RGR was noticed with 25 days nursery transplanting on 25 June and lowest with 39 days nursery transplanting on 9 July. The same trend was observed as in case of CGR. Among the foliar supplements, foliar nutrition had significant impact till 30-60 DAT, thereafter non-significant impact during 60-90 DAT and 90-120 DAT. At 30-60 DAT, the highest RGR recorded with foliar spray 2% NPK at active tillering followed by 1% KNO_3 which was at par with foliar spray of 2% urea followed by 1% MOP.

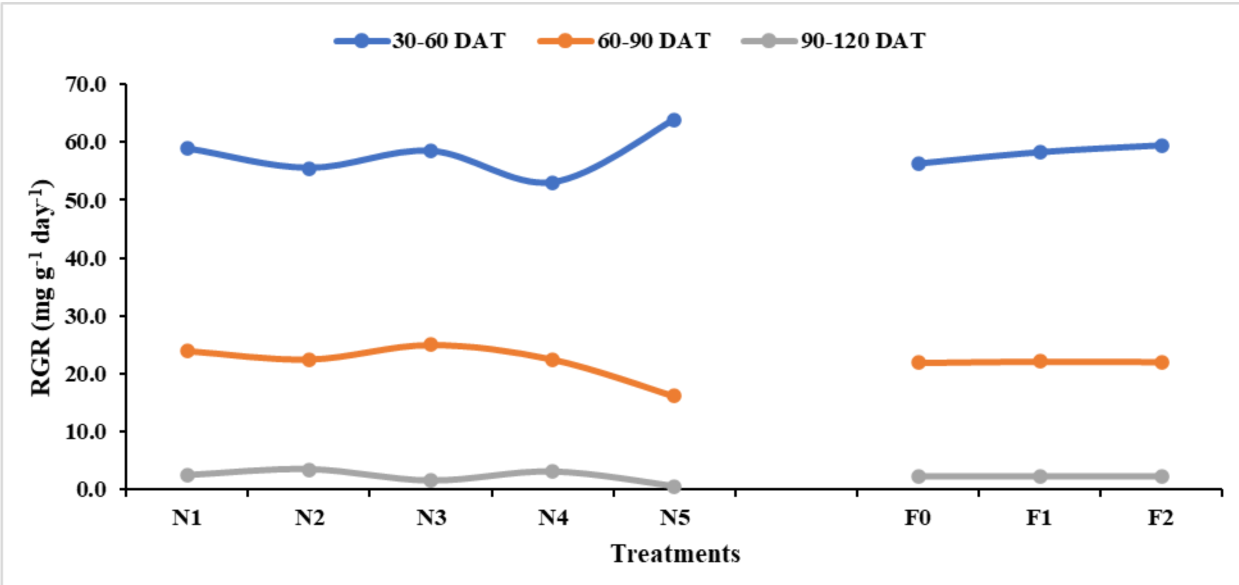

Fig.2. Effect of seedling age, transplanting time and foliar nutrition on relative growth rate

Conclusion

The maximum dry matter accumulation and growth was recorded in 25 days nursery transplanting on 25 June(N1) which was at par with 25 days nursery transplanting on 2 July(N2) and 32 days nursery transplanting 2 July(N3). The reduction in growth was recorded with 39 days nursery (N5) and late nursery sowing(N4) treatments. Among foliar treatments, foliar supplements significantly improved dry matter accumulation at all growth stage over control treatment whereas CGR and RGR were significantly influenced by foliar nutrition up to 60 days of transplanting. At later stage it was found non-significant, it may be because of potassium contributing more in partitioning of photosynthes at reproductive stage. In the present study it has been observed that foliar application of high grade water soluble fertilizer like NPK(19:19:19) and KNO_3 were found more effective as compared to low grade fertilizer like urea and MOP.

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