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# Performance of Puddled Transplanted Rice due to Delayed Basal and Varied Time of Nitrogen and Potassium Application

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**A B S T R A C T**

A field investigation was made during the late *samba* (September - January) season of 2019-20 at Tamil Nadu Agricultural University, Coimbatore to study the performance of puddled transplanted rice due to delayed basal and varied time of nitrogen and potassium application .The experiment was laid out in Randomized Complete Block Design with three replications. The treatment comprised of $T_1$ - Control (Basal application of N and K before transplanting with three top dressings), $T_2$ - N and K application on 3 Days After Transplanting (DAT) with 3 top dressings, $T_3$ - N and K application on 7 DAT with 3 top dressings, $T_4$ - N and K application on 10 DAT with 3 top dressings, $T_5$ - N and K application on 15 DAT with 3 top dressings,$T_6$ - N and K application on 7 DAT with 2 top dressings, $T_7$ - N and K application on 10 DAT with 2 top dressings and $T_8$ - N and K application on 15 DAT with 2 top dressings. The result showed that delayed basal application of N and K at 15 DAT with three top dressings ($T_5$) recorded significantly higher plant height, LAI, drymatter production, panicle length, panicle weight, number of grains/panicle, filled grains /panicle led more grain (6346 kg/ha) and straw (8800 kg/ha) yields than others; but with delayed basal N and K application at 15 DAT with two top dressings, 10 DAT with three top dressings /two top dressings ($T_8$, $T_4$ and $T_7$).

## Introduction

Rice (*Oryza sativa* L.) is one of the most important food crops in India, contributing to 40 per cent of total food grain production. It plays a vital role in food security and livelihood for almost every household. Fertilizers played a key role in modernization of Indian agriculture. Fertilizer is one of the inputs which bring quantum jump in yield of rice. Nutrient uptake by rice plant is different from other field crops since it is grown under submergence which results in a series of physio chemical and biochemical changes (Huang *et al.*, 1995). Nitrogen and potassium are the major essential plant nutrients and a key input for increasing crop yield. Optimum dose of nitrogen and potassium fertilization plays a vital role in the growth and development of rice plants. Yield increase (70-80%) of field rice could be obtained by the application of nitrogen fertilizer (IFC, 1982). Nitrogen has a positive influence on the production of effective tillers/plant, yield and yield attributes (Jashim *et al.*, 1984). Potassium is required for the activity of many enzymes, including those of energy metabolism, protein synthesis and solute transport. Also it contributes significantly to cell turgor, especially in rapidly expanding cells and acts as a counter cation for anion accumulation and electrogenic transport processes (Amtmann *et al.*, 2006; White and Karley, 2010).

In low land rice ecosystems in wet season, usually nitrogen use efficiency is approximately 30-40 per cent (Ramakrishnan *et al.*, 2007) and rest of 60-70 per cent being lost by way of denitrification, ammonium volatilization, leaching, runoff and immobilization. Lack of potassium restricts the establishment, development and yield of crops (Rengel and Damon, 2008).

Kimura and Chiba (1943) considered that the time at which nutrients are absorbed would influence the yield more than the amount of nutrients absorbed by the crop. Therefore, it is essential to find out the optimum time of nitrogen and potassium application to reduce the risk of different losses. The results of several studies indicated that delaying the basal application of fertilizer N and K is beneficial to rice (Sahoo *et al.*, 1990). If the basal application of N and K is delayed up to seedling establishment, there will be greater chances of N and K recovery and yield improvement. There is risk of more N and K loss if larger quantity of N and K is applied as a single dose. Split application is one of the strategies for the efficient use of N and K fertilizer throughout the growing season. Synchronizing the nutrient application with plant demand increases the nutrient uptake and yield. LCC based N management is the optimal N fertilization strategy for rice, since it gives higher yields besides it is an effective way for saving of N as compared to blanket N recommendation. Hence, keeping the above points, the present study was undertaken to optimize the time of basal and split application of N and K to rice.

## Materials and Methods

### Experimental details

The field study was conducted during the late *samba* (September - January) season of 2019-20 at Wetland farms, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore located in western Agro-climatic zone of Tamil Nadu ($11^0$ 02’N latitude and $76^0$93’ E longitude, with altitude of 426.7 m above MSL). The experimental soil was clay loam in texture with slightly alkaline reaction (pH of 8.1) and a non saline condition (0.5 dS/m).The initial nutrient status of the soil was low in available N (246.3 kg/ha), high in available P (39.7 kg/ha) and high in available K (621.4 kg/ha). The recently released TNAU variety, CO 52 with maturity duration of 130-135 days with an average yields of 6191kg/ha was used for the study.

The experiment was laid out in Randomized Completely block Design (RCBD) and consists of eight treatments and three replications. The treatment comprised of: $T_1$ - Control (Basal application of N and K before transplanting with three top dressings),$T_2$ - N and K application at 3 Days After Transplanting (DAT) with 3 top dressings, $T_3$ - N and K application at 7 DAT with 3 top dressings,$T_4$ - N and K application at 10 DAT with 3 top dressings,$T_5$ - N and K application at 15 DAT with 3 top dressings,$T_6$ - N and K application at 7 DAT with 2 top dressings,$T_7$ - N and K application at 10 DAT with 2 top dressings,$T_8$ - N and K application at 15 DAT with 2 top dressings.

Three kilograms of seeds were kept for 10 hours soaking followed by incubation for 24 hrs in dark room to enhance germination. Pre-germinated seeds were sown on 30th September, 2019 on raised nursery beds. Field was first ploughed using 11 tine cultivator twice, followed by puddling by roto-puddler after stagnating water for two days. Transplanting was carried out in a well puddled and levelled field on 15th October, 2019 (14 DAS) at single seedling/hill with spacing of 25 × 25 cm. Gap-filling was done on 10 DAT in all the plots for maintaining optimum population.

The recommended dose of fertilizer for medium duration variety is 150:50:50 kg N: $P_2O_5$:$K_2O$/ha. Urea (46% N), single super phosphate (16% $P_2O_5$) and muriate of potash (60% $K_2O$) were used as the source of nitrogen, phosphorous and potassium, respectively. Full dose of phosphorus was applied as basal to all the plots prior to transplanting as per the recommendation. Twenty five per cent of basal dose of N and K was delayed by 3, 7, 10 and 15 DAT as per treatment schedule. The rest of 75 per cent was given in three equal splits and reduced to 50 per cent given as two splits as per the treatment. Three splits is based on critical stages *viz.*, at active tillering (50 DAT), panicle initiation (70 DAT) and heading stages (100 DAT) and two splits is based on LCC observations. All other package of practices were carried out as per CPG (2019).

The plant height of five tagged plants from each treatment plot were measured from the ground level to the tip of panicle at maturity stage and the mean value expressed in centimetre. The leaf area index was calculated as suggested by Palanisamy and Gomez (1974), using the formula as given below:

$$\text{LAI} = \frac{\text{L} \times \text{B} \times \text{K} \times \text{Total number of green leaves/hill}}{\text{Spacing (cm}^2)}$$

Where, L, B and K are length and breadth of the third leaf from the top (cm) and constant (0.75), respectively.

The total number of tillers and productive tillers produced in the individual hill from five randomly tagged plants were recorded and the average was expressed as number of tillers/$m^2$ and number of productive tillers/$m^2$, respectively. Total number of grains, number of filled grains and chaffy grains in a panicle were counted separately in ten randomly selected panicles from five tagged hills of each treatment plot and the mean value was recorded as number of grains/panicle, number of filled grains/panicle and chaffy grains/panicle, respectively. The panicle length was measured from the scar to the tip of the panicle in centimeter (cm) and the panicle weight in grams (g) from ten randomly selected panicles the mean value was recorded. From each treatment plot, one thousand grain weight at 14 per cent moisture content was recorded in grams (g). Grain weight at moisture content of 14 per cent and straw weight were taken separately from each treatment plots after hand threshing and was expressed in kg/ha.

The recorded data were statistically analysed as described by Gomez and Gomez (2010) by the Least Significant Difference (LSD) test at 5 per cent level of probability.

## Results and Discussion

### Plant height (cm)

Delayed basal and number of split doses of N and K application in rice altered the plant height significantly. Application of N and K at 15 DAT with three top dressings at critical stages ($T_5$) produced significantly taller plants (115.6 cm) over other treatments. However, it was statistically on par with N and K application at 10 DAT with three top dressings ($T_4$), N and K application at 15 DAT with two top dressings based on LCC observations ($T_8$) and N and K application at 10 DAT with two top dressings based on LCC observations ($T_7$). The shortest rice plants (96.8 cm) were recorded in control basal N and K application before transplanting with three top dressings ($T_1$). The favourable influence of delaying the basal application of N and K up to tillering stage on the growth of rice might be due to active absorption of nutrients by the well developed roots. Islam *et al.,* (2009) observed that delaying the basal application of N up to 15 DAT recorded taller plants.

## Leaf area index (LAI)

There existed a significant difference in LAI due to delayed basal and varied time of N and K application. Significantly higher LAI (5.47) was observed on delaying the basal N and K application up to 15 DAT with three top dressings ($T_5$) followed by N and K application at 15 DAT with two top dressings and N and K application at 10 DAT with three top dressings ($T_8$ and $T_4$) which were on par with each other. A lowest LAI (3.51) was recorded in control (basal N and K application before transplanting with three top dressings - $T_1$). Higher LAI in delaying basal N and K was due to well established seedlings increased the foraging capacity of the plants and resulted in the production of more and larger leaves by increased uptake of N which, in turn, contributed to higher LAI. Similar results were reported by Choubey *et al.,* (1985).

## Tiller characteristics

Significant difference in tiller production was noted with delayed basal and different split application of N and K. Significantly higher number of tillers (485/$m^2$) was observed in delaying N and K application up to 15 DAT with three top dressings ($T_5$) than other treatments. The lowest number of tillers (271/$m^2$) was recorded in basal N and K application before transplanting with three top dressings ($T_1$). Higher number of tillers/$m^2$ in delaying N and K application up to 15 DAT with three top dressings was due to greater nutrient uptake as evidenced in the present study.

The number of productive tillers was higher (330.1/$m^2$) at N and K application 15 DAT with three top dressings ($T_5$) compared to other treatments. It was due to steady and continuous supply of N absorbed by the well established seedlings which synchronized with the stages of vigorous absorption by the crop. This was in line with the results of Govindan (1985).

## Drymatter production

Distinguishable variations are noted in drymatter production due to delayed basal and different time of N and K application. Delayed basal N and K at 15 DAT and application of N and K at three stages ($T_5$) increased the drymatter production (15368 kg/ha) significantly compared to other treatments. This was due to increased plant height, tiller number and LAI which in turn would have produced higher DMP. Improved vegetative growth promoted higher DMP (Tamizharasan, 1987). An increase in N application and availability had resulted in higher N content in plants and increased the DMP. Similar finding was reported by Prasad and Prasad (1983). Least DMP was recorded in basal application of N and K before transplanting with three top dressings ($T_1$).

## Panicle parameters

Panicle characters were significantly influenced by delayed basal and split application of N and K. A significantly higher panicle length (29.02 cm) was recorded in delaying the basal application of N and K up to 15 DAT with three top dressings ($T_5$) over others, but was on par with N and K at 15 DAT with two top dressings ($T_8$). A lower panicle length (23.02 cm) was recorded in basal application of N and K before transplanting with three top dressings ($T_1$). Production of lengthy panicles with more number of grains per panicle in delayed basal N application at 15 DAT might be due to enhanced nutrient uptake and better nutritional environment at the reproductive stage. Similar result was reported by Ali *et al.,* (2015). Application of N in three splits corresponded with the stages of vigorous absorption and efficient N assimilation enabled lengthier panicles with more number of grains due to greater photosynthate production. The crop produced maximum panicle length in response to N and K application in two splits also. This was in agreement with Raza *et al.,* (2003).

Panicle weight was significantly influenced by delaying the basal application of N and K. Higher panicle weight (2.82 g) was recorded in delaying the basal application of N and K up to 15 DAT with three top dressings ($T_5$) compared to others. Whereas, it was on par with N and K application at 15 DAT with two top dressings ($T_8$) and N and K application at 10 DAT with two top dressings ($T_7$). Delaying the basal application of N and K at 15 DAT increased the panicle weight which was due to increased panicle length, more number of grains per panicle and filled grain percentage recorded with this treatment.

## Grain characteristics

Total number of grains/panicle showed significant variation, where, higher number of grains (301/panicle) was found in delaying basal application of N and K up to 15 DAT with three top dressings ($T_5$) which was statistically identical to N and K application at 10 DAT with three top dressings ($T_4$) and N and K at 15 DAT with two top dressings ($T_8$). A lower number of grains (222.5 /panicle) were recorded at basal N and K before transplanting with three top dressings ($T_1$) which was on par with N and K application at 3 DAT with three top dressings ($T_2$) and N and K application at 7 DAT with two top dressings ($T_6$).The most appropriate time of nitrogen application to rice is panicle initiation, which produced maximum number of grains/panicle (Bacon, 1980; Inthavongra *et al.,* 1985). Number of filled grains increased with every increase in number of equal split application of N from two to four splits (Youseftabar *et al.,* 2012).

Delaying the basal N and K application had a significant influence on number of filled grains/panicle, which was higher (277.4/panicle) in delaying the basal application of N and K up to 15 DAT with three top dressings ($T_5$) than other treatments. However, it was statistically identical to N and K at 10 DAT with three top dressings ($T_4$). The numbers of filled grains in a panicle were lower (175.4/panicle) in basal application of N and K before transplanting with three top dressings ($T_1$) which maintained statistical parity with N and K at 3 DAT with three top dressings ($T_2$) and N and K at 7 DAT with two top dressings ($T_6$). The number of filled grains/panicle increased with nitrogen application from 15 DAT with three top dressings might be due to higher availability of nitrogen at panicle initiation and grain development stages. The contribution of carbohydrates from photosynthetic activity for longer period might have resulted in efficient translocation of food material into the sink (grain) thereby increase the number of filled grains/panicle. Similar results were reported by Anusha (2016) and Biswajit *et al.,* (2017) (Table 1).

**Table.1** Effect of delayed basal and varied time of N and K application on the growth characters of rice

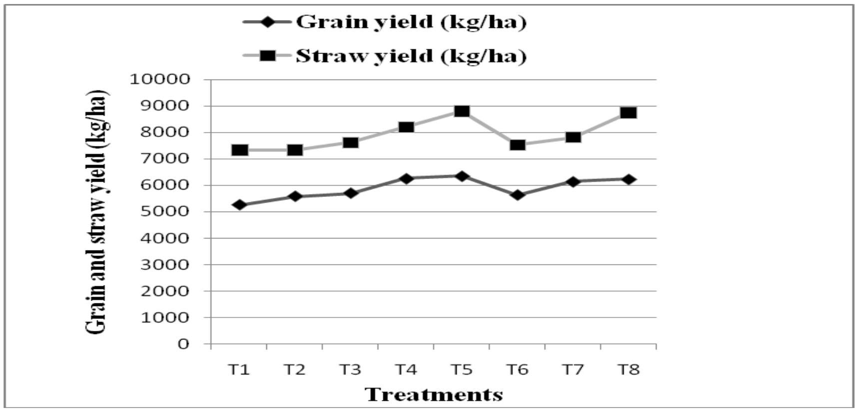
| Treatments | Plant height at maturity (cm) | LAI at flowering stage | Tiller/m$^2$ at maturity | Dry matter production (kg/ha) |
|---|---|---|---|---|
| **$T_1$: N and K Basal before transplanting + 3 top dressings** | 96.8 | 3.51 | 271.2 | 12700 |
| **$T_2$: N and K 3 DAT+ 3 top dressings** | 99.2 | 4.40 | 310.0 | 13119 |
| **$T_3$: N and K 7 DAT+ 3 top dressings** | 104.2 | 4.63 | 417.6 | 13640 |
| **$T_4$: N and K 10 DAT+ 3 top dressings** | 110.5 | 5.30 | 432.0 | 15111 |
| **$T_5$: N and K 15 DAT+ 3 top dressings** | 115.6 | 5.47 | 485.0 | 15368 |
| **$T_6$: N and K 7 DAT+ 2 top dressings** | 100.5 | 4.60 | 401.0 | 13567 |
| **$T_7$: N and K 10 DAT+ 2 top dressings** | 107.4 | 4.70 | 416.0 | 14230 |
| **$T_8$: N and K 15 DAT+ 2 top dressings** | 108.6 | 5.35 | 429.6 | 15045 |
| **SEd** | 5.0 | 0.28 | 16.1 | 699 |
| **CD (P=0.05)** | 10.7 | 0.60 | 34.6 | 1499 |

DAT: Days After Transplanting, Three top dressings based on critical stages (active tillering, panicle initiation and heading stage) and two top dressings based on LCC (Leaf Colour Chart). The critical difference was worked out of 5 per cent ($P$=0.05) level to evaluate the significant difference between the means by one way ANOVA statistics. SEd: Standard error of difference

**Table.2** Effect of delayed basal and varied time of N and K application on yield attributes of rice

| Treatments | Productive tillers/m$^2$ | Panicle length (cm) | Panicle weight (g) | Number of grains/ panicle | Filled grains/ panicle | Chaffy grains/ panicle | 1000 seed weight |
|---|---|---|---|---|---|---|---|
| **$T_1$: N and K Basal before transplanting + 3 top dressings** | 255.6 | 23.02 | 2.22 | 222.5 | 175.4 | 47.50 | 14.00 |
| **$T_2$: N and K 3 DAT+ 3 top dressings** | 261.3 | 23.90 | 2.37 | 224.0 | 183.4 | 40.60 | 14.17 |
| **$T_3$: N and K 7 DAT+ 3 top dressings** | 282.1 | 25.82 | 2.50 | 240.6 | 221.3 | 19.30 | 14.23 |
| **$T_4$: N and K 10 DAT+ 3 top dressings** | 296.2 | 26.36 | 2.59 | 282.0 | 255.0 | 27.00 | 14.30 |
| **$T_5$: N and K 15 DAT+ 3 top dressings** | 330.1 | 29.02 | 2.82 | 301.0 | 277.4 | 23.60 | 14.38 |
| **$T_6$: N and K 7 DAT+ 2 top dressings** | 274.3 | 24.10 | 2.42 | 248.0 | 194.5 | 53.50 | 14.17 |
| **$T_7$: N and K 10 DAT+ 2 top dressings** | 288.2 | 26.01 | 2.61 | 254.0 | 231.2 | 22.80 | 14.20 |
| **$T_8$: N and K 15 DAT+ 2 top dressings** | 295.3 | 27.10 | 2.72 | 281.0 | 236.4 | 44.60 | 14.30 |
| **SEd** | **11.9** | **10.9** | **0.10** | **10.9** | **12.5** | **1.87** | **1.00** |
| **CD (P=0.05)** | **25.5** | **23.4** | **0.22** | **23.4** | **26.9** | **4.02** | **2.15** |

**Fig.1** Effect of delayed basal and varied time of N and K application on yield of rice




Chaffy grains/panicle was significantly influenced by delaying the basal N and K application. Higher number of chaffy grains (53.5/panicle) was recorded in N and K application on 7 DAT with 2 top dressings ($T_6$). The number of unfilled grains in a panicle was lower (19.3/panicle) in N and K at 7 DAT with three top dressings ($T_6$). Grain filling depends on total photosynthetic ability, number of panicles produced/$m^2$ and nutrient supply (Prasad *et al.,* 1982). Increased number of grains and grain filling percentage might be due to fractional application of N and K in three splits. These results are in close confirmation with that of Krishnan and Nayak (2000) who had reported higher number of filled grains with split application of N.

Test weight (1000 grains) recorded was statistically identical in all the treatments since test weight is a varietal characteristics which is seldom affected by nutrient management.

## Yield of rice

Grain yield was significantly influenced by delayed basal N and K application. A significantly superior grain yield (6346 kg/ha) was recorded in delaying the basal application of N and K up to 15 DAT with three top dressings ($T_5$) which was statistically identical to N and K at 10 DAT with 3 top dressings ($T_4$), N and K at 15 DAT with 2 top dressings ($T_8$) and N and K at 10 DAT with 2 top dressings ($T_7$). The yield obtained under the rest of the time of nutrient application was statistically identical. The least yield (5255 kg/ha) was recorded in basal application of N and K before transplanting ($T_1$). The marked increase in grain yield by the application of N and K in three splits favorably influenced on growth characters and yield attributed as evidenced in the present study by effective utilization of N and K at needy stages of the crop growth from seedling to maturity which have ultimately led to higher grain yield. This was in accordance with the findings of Manzoor *et al.,* (2006) (Fig. 1 and Table 2).

Similar trend was observed in straw yield of rice too. Higher straw yield (8800 kg/ha) was recorded in $T_5$ which was on par with $T_8$, $T_4$ and $T_7$. Application of potassium in proper time (split doses) enhanced the enzymatic activities and translocation of photosynthetics in plant system, which ultimately resulted in higher grain and straw yield. Devasenapathy (1997) and Pal *et al.,* (2000) have also reported similar results.

The results of the study have clearly indicated the positive effect of delaying the basal N and

K and its fractional application at different growth stages. It is concluded that though the delayed basal application of N and K at 15 days after transplanting with the application of N and K in three top dressings produced better growth and yield characters, basal application of N and K at 15 days after transplanting with the application of N and K in two top dressings based on LCC observations was on par and hence, it is found appropriate N and K management technique to increase the N and K use efficiency and to get higher production and economic returns in puddled transplanted rice.

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