*Int.J.Curr.Microbiol.App.Sci* (2020) *9*(2): 2025-2035

EXCELLENT PUBLISHERS

*International Journal of Current Microbiology and Applied Sciences*
***ISSN: 2319-7706*** **Volume 9 Number 2 (2020)**
Journal homepage: http://www.ijcmas.com

**Original Research Article** https://doi.org/10.20546/ijcmas.2020.902.231

# Effect of Nitrogen on Growth, Yield and Nutrient Uptake of Rice under Aerobic Condition

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**Keywords**

aerobic rice, Yield, N, P & K uptake, B: C ratio

**Article Info**

***Accepted:***
15 January 2020
***Available Online:***
10 February 2020

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

A field experiment was undertaken during *kharif* of the year 2016 at the Research Farm of Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur), Bihar. The experiment was conducted in split plot design having three levels of nitrogen in main plots ($N_1$-120 kg N/ha, $N_2$-140 kg N/ha and $N_3$-160 kg N/ha,) and six weed management practices ($W_1$- Pyrazosulfuron @ 25 g/ha (20 DAS), $W_2$-Bispyribac sodium @ 25 g/ha (20 DAS), $W_3$-Pyrazosulfuron @ 25g/ha + Bispyribac sodium @ 25g/ha (20 DAS), $W_4$ Pendimethalin @ 1000g/ha (PE)+ $W_3$ (20 DAS), $W_5$-Weed free (2 Hand weeding at 20 & 40 DAS) and W6-Weedy check) in sub plots, replicated thrice with Abhishek as the test variety. Higher level of nitrogen i.e. 160 Kg/ha exhibited better expression in respect of growth and yield attributes than the other two levels and it was somehow also comparable to 140 kg N/ha. The better performance in terms of growth and yield attributed were reflected correspondingly in grain and straw yield however harvest index didn't show any significant variation due to nitrogen treatments. Nutrient uptake by crop was higher in 160 kg N/ha than other two lower doses. Amongst the two lower doses of nitrogen, 140 kg N/ha had an edge over 120 kg N/ha. The most glaring part of results rested in its economic studies, wherein treatment with 160Kg N/ha fetched higher gross returns, net return and finally B:C ratio than other two doses.

## Introduction

Rice is the world's most important crop and more than half of the world's population depends on it for food, calories and protein especially in developing countries however it is the biggest user of freshwater. Rice production consumes about 30% of all fresh water used worldwide. Flood-irrigated rice uses two to three times more water than other cereal crops such as wheat and maize. In wet rice cultivation, it takes 2000 to 3000 liters of water to produce 1 kg of rice. However, scarcity of freshwater resources has threatened the production of the flood-irrigated rice crop (IWMI, 2000). By 2025, 15 out 75 million hectare of Asia's flood-irrigated rice crop will experience water shortage (Tuong and Bouman, 2003). So, alternative to transplanting could be aerobic rice because it requires less water, less labour and capital.

Aerobic rice system, wherein the crop is established via direct seeding in non- puddled, non flooded fields are the most promising approach for saving water (Tuong and Bhushan *et al.,* 2007). Aerobic rice can reduce water application by 44% relative to conventionally transplanted system by reducing percolation, seepage and evaporative loss (Bouman *et al.*, 2005). Direct seeded culture has become increasingly important in rice cultivation due to scarcity of farm labour and higher water requirement and higher production cost of transplanted rice (Azmi and Baki, 2007). Direct seeded rice needs only 34% of the total labour requirement and saves 27% of the total cost of the transplanted crop (Mishra and Singh, 2011). Direct seeding of rice also allows early establishment of the succeeding wheat crop. Aerobic rice system is subjected to much higher weed pressure than conventional puddled transplanted system (Rao *et al.*, 2007) in which weeds are suppressed by standing water. Weeds are the most severe constraints and timely weed management is crucial for increasing the productivity of rice under aerobic condition. Uncontrolled weeds reduce the yield by 96% in dry direct-seeded rice and 61% in wet direct-seeded rice (Maity and Mukherjee, 2008). During peak period, the availability of labour is becoming a serious problem by time in all parts of country. So, Herbicides are used successfully for weed control in rice fields for rapid and effective result, easier to application and low cost involvement in comparison to the traditional methods of hand weeding.

Nitrogen is one of the most important yield limiting nutrients affecting growth and quality in rice system (De Datta *et al*., 1988; Khan *et al*., 2012) and accounts for 67% of the total applied fertilizers worldwide (Vlek and Byrnes, 1986). Nitrogen use efficiency (NUE) of rice is usually low due to volatilization, runoff, denitrification and leaching losses (Modgal *et al*., 1995). Moreover, direct seeded rice soils are often exposed to dry and wet conditions and difference in N dynamics and losses pathways often results in different fertilizer recoveries in aerobic soils (De Datta and Buresh, 1989). Even high and non-synchronous applied nitrogen may limit grain yield due to limited grain filling rate by decrease in post anthesis assimilates translocation (Zhang *et al*., 2009). Thus, Nitrogen and weeds are the two important factors that influence the productivity of rice under aerobic condition in tropical Asia.

## Materials and Methods

The experiment was laid out in Nursery Jhilli Field at Dr. Rajendra Prasad Central Agricultural University, Pusa farm situated on the southern bank of the river *Budhi Gandak* in Samastipur district (25.590 N and 84.400 E and 52.3 m above the mean sea level). Soil of the experimental site was calcareous (clay loam) and relatively low fertile with pH 8.4, organic carbon 0.43%, available NPK 209, 20.8 and 116.4 kg/ha respectively. The total rainfall of 770.7 mm was recorded during cropping period of 2016. The experiment was conducted during *kharif* of 2016 in split plot design with three replications. The factors under study comprised three Nitrogen levels i.e. $N_1$-120 kg N/ha, $N_2$ -140 kg N/ha, $N_3$ -160 kg N/ha in main plots and 6 weed management treatments on rice under aerobic condition i.e. $W_1$ - Pyrazosulfuron @ 25 g/ha (20 DAS), $W_2$ - Bispyribac sodium @ 25 g/ha (20 DAS), $W_3$ - Pyrazosulfuron @ 25 g/ha + Bispyribac sodium @ 25 g/ha (20 DAS), $W_4$ - Pendimethalin @ 1000g/ha (PE) + $W_3$ (20 DAS), $W_5$- Hand weeding at 20 & 40 DAS, $W_6$- weedy check in sub-plots. The variety used was Abhishek. It is long duration (110-115 days) rice variety suitable for irrigated condition. Seed rate was 40 kg/ha and treated seeds were sown in rows with 20 cm row to row spacing. Half dose of nitrogen (as per the treatments through urea) and full dose of phosphorus and potash (50-30 kg $P_2O_5$-$K_2O$/ ha through SSP and MOP) were applied as basal dose at the time of sowing and remaining half dose of nitrogen was applied in two equal split at 30 and 60 DAS i.e. at tillering and panicle initiation stage. Herbicides were applied with the help of Knapsack sprayer fitted with flat fan nozzle. The crop was manually harvested and threshed in the third week of November. Data were recorded on weeds, growth attributes, yield and economics of rice crop. The process of estimation of N, P & K uptake are mentioned below:

### Nutrient uptake

### Nitrogen uptake

The nitrogen content in plant was determined by Kjeldahl's method (Jackson, 1973)**.** The grain and straw were separated and then grinded. The grinded material was digested in concentrated sulphuric acid using copper sulphate and potassium sulphate mixture as catalyst. The digested material was then distilled with 40 percent sodium hydroxide and distillate was collected in boric acid containing the mixed indicator. The content was estimated by titrating the distillate against N/20 sulphuric acid. The nitrogen uptake was calculated by multiplying the dry weight with nitrogen content. In order to get total uptake of nitrogen, the uptake values for grain and straw were added together.

### Phosphorus uptake

Total phosphorus uptake was determined in the extract by Vanedo molybdate yellow color method (Jackson, 1973). The optical density (OD) was measured with photoelectric colorimeter at 470 nm. The content was estimated with calibration curve. The phosphorous uptake by grain and straw per hectare was calculated with the help of per cent value of phosphorus and yield of grain and straw. In order to get uptake of phosphorous, the uptake value for grain and straw were added together plot wise.

### Potassium uptake

The potassium content was determined with the help of flame photometer (Jackson, 1973) and was estimated with calibration curve. Total uptake of potassium by rice grain and straw was calculated by multiplying their relative contents with yield of grain & straw and values were added to know the total uptake of potassium in kg/ha.

The Crop Growth Rate (CGR) were calculated by using following formulae:

$$CGR\ (g/m^2/day) = W_2\text{-}W_1/t_2\text{-}t_1$$

Where, $W_1$ & $W_2$ are plant dry weights ($g/m^2$) at time $t_1$ & $t_2$ respectively.

## Results and Discussion

The plant height was significantly influenced by different nitrogen levels except at 30 DAS, where the application of 160 kg N/ha caused the significant increase in plant height over 120 kg N/ha but it was at par with 140 kg N/ha. The other growth characters viz. number of tillers/m row length, dry matter production at progressive growth stages, and crop growth rates were also affected significantly due to different nitrogen levels. However, nitrogen level of 160 kg/ha significantly had better growth expression than other two nitrogen levels. Nitrogen level of 120 kg N/ha had significantly the lowest values for all these growth characters. In the present investigation number of panicles/m row length, number of spikelet per panicle, number of fertile spikelet per panicle and 1000-grain weight was the four yield attributes studied. The plots with 160 kg N/ha had significantly the best expression in term of all the four yield attributes. Nitrogen, Phosphorus and Potassium uptake by crop were affected significantly due to different nitrogen levels and weed management practices. Quite in league with the performances as regards growth and development, the treatment comprised of 160 kg N/ha out classed the other two treatments in respect of gross return, net return as well as B: C ratio.

## Effect on growth characters

The rice plants growing under treatment with 120 kg N/ha had the shortest plants. This trend was there right from the vegetative, log-vegetative and reproductive phases. Two other nitrogen levels i.e. 140 kg N/ha and 160 kg N/ha fared equally well in this regard. However, treatment with 140 kg N/ha (42.48, 75.93, 103.88 & 107.52 m at 30, 60, 90 DAS & At harvest respectively) had an edge of 160 kg N/ha (44.38, 78.80, 109.10 & 112.63 m at 30, 60, 90 DAS & At harvest respectively) though not attaining a difference adequate to be termed as significant. Nitrogen is associated with protoplasm synthesis and vigorous vegetative growth due to increased cell division and cell elongation. Hence, application of nitrogen resulted in significant increase in plant height at early stages of crop growth. Similar findings were reported by Maheswari *et al.,* (2008) and Sathiya and Ramesh (2009).

Total number of tillers /meter row length counted at 30, 60, 90 DAS and at harvest (39.05, 92.45, 76.77 & 74.93 respectively) was recorded significantly higher with 160 kg N/ha. Total number of tillers per meter row length tended to increase up to 60 DAS and beyond which declined towards harvest. Increasing levels of nitrogen progressively enhanced the total number of tillers at all the stages of observations and it was due to more nitrogen supply at active tillering stages. These results were in conformity with the findings of Jadhav *et al.,* (2006).

Dry matter production of aerobic rice tended to increase progressively with an advance in the age of the crop up to harvest. Among the different nitrogen levels tried, highest dry matter production (156.10, 462.40, 677.52 & 842.50 $g/m^2$ at 30, 60, 90 DAS and at harvest respectively) of aerobic rice was produced with the application of 160 kg N/ha which was however significantly higher than that of other treatments. Lowest dry matter production was recorded with 120 kg N/ha. This might be due to cumulative effect of photosynthesis due to taller plants with more number of tillers because of increased availability of vital nutrients led to increased dry matter production. This positive effect of nitrogen on dry matter has been documented earlier by Devi and Sumathi (2011).

## Effect on yield attributes and yield

The plots with 160 kg N/ha had significantly the best expression in term of all the four yield attributes i.e. number of panicles/m row length, number of spikelet per panicle, number of fertile spikelet per panicle and 1000-grain weight. The treatment next in order was comprised of 140 kg N/ha. The treatment with 160 kg N/ha had the maximum panicles/m row length (71.41) maximum number of spikelet/panicle (140), maximum number of fertile spikelet per panicle (121) and the heaviest test weight (1000-grain weight of 24.65 g). Commensurating with the performances in terms of yield attributes, both grain yield and straw yield too were the maximum (36.22 and 48.03 q/ha) under treatment having 160 kg N/ha. However, the yields (grain and straw) obtained under 140 kg N/ha fared equally well (33.95 & 44.25 q/ha) with regard to yield parameters establishing parity with 160 kg N/ha.

The yield was better due to less competition, and comparatively better availability of inputs involved in manufacture of building blocks for plant bodies. Simply one fact may be added here that the yield and yield attributes are more prone to weed competition than growth parameters as the growing meristematic tissues in rice plants remains below the ground level for greater part of vegetative growth. Whereas, the growing point in rice comes above the ground level and face more severe competition with weeds when yield attributes form in the plant body (Evans, 1979). Lower harvest index under weedy check condition may be explained on the basis that the menace of weeds go an increasing with increase in age. Hence, the vegetative growth was affected comparatively less. The results with regard to yield attributes and yield having developed under the influence of different nitrogen levels are in close conformity with the results reported earlier from Thimmegowda *et al.,* (2009).

## Effect on nutrient uptake

Uptake of N, P and K were the maximum under treatment with 160 kg N/ha (70.29, 14.82 & 64.30 kg/ha respectively). Treatment with 140 kg N/ha (64.58, 12.24 & 57.70 kg/ha respectively) was the next in order. The least uptake of N, P and K were recorded in the plots having 120 kg N/ha. There is not much to explain the behaviour of treatments as crop uptake is directly a function of biological yield.

The plots giving higher biological yields exhibited higher nutrient uptake and so on in other cases. Similarly, as the treatment with 160 kg N/ha offered greater opportunity to crop to come up and grow, their weeds took up a lion's share of nutrients from the plots. This was mainly due to better control of weeds during active crop growth stages which helps in minimizing the crop weed competition and help the crop to utilize more nitrogen and other nutrients and led to better crop growth. Lower nutrient uptake might be due to severe competition offered by weeds for nutrients throughout the crop growth period which suppress the crop and severely affecting the crop growth. This result was in conformity with Singh and Tripathi (2007).

## Effect on economic aspects of rice cultivation

Quite in league with the performances as regards growth and development, the treatment comprised of 160 kg N/ha out classed the other two treatments in respect of gross return, net return as well as B: C ratio. The above mentioned treatment earned a net return of □ 31,645/ha with a B: C ratio of 1.09. As against this, the treatment with 140 kg N/ha fetched a net return of □ 27,989/ha concerning a B: C ratio of 0.97. These two nitrogen levels were superior to 120 kg N/ha which realized a net return of □ 23,927/ha having a B: C ratio of 0.84.

The treatment with 160 kg N/ha, however, was adjudged comparable to the treatment with 140 kg N/ha, but was significantly superior to 120 kg N/ha with regard to gross return, net return and B: C ratio. It is a fact that higher grain yield as well as straw yield obviously resulting in higher net return. Thus, the economic aspect virtually remains a reflection of economic yield and guide naturally the treatments found superior in economic yields were also superior in return and benefit: cost ratio. The findings of this investigation as regards economic aspects are quite in agreement with those reported by Devi and Sumathi (2011).

**Table.1** Effect of different treatments on plant height (cm) and No. tillers/m row length at different stages of crop growth

| Treatments | Plant height (cm) | | | | No. of tillers/m row length | | | |
|---|---|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | At harvest | 30 DAS | 60 DAS | 90 DAS | At harvest |
| **Nitrogen levels** | | | | | | | | |
| **$N_1$ - 120 kg N/ha** | 39.70 | 72.78 | 97.85 | 102.73 | 34.03 | 78.13 | 66.18 | 64.70 |
| **$N_2$ - 140 kg N/ha** | 42.48 | 75.93 | 103.88 | 107.52 | 36.12 | 86.20 | 69.60 | 70.47 |
| **$N_3$ - 160 kg N/ha** | 44.38 | 78.80 | 109.10 | 112.63 | 39.05 | 92.45 | 76.77 | 74.93 |
| **SEm±** | 0.77 | 0.23 | 0.55 | 0.50 | 0.41 | 0.58 | 0.32 | 0.43 |
| **CD (P=0.05)** | 3.09 | 0.91 | 2.22 | 2.00 | 1.64 | 2.34 | 1.29 | 1.74 |
| **Weed management** | | | | | | | | |
| **$W_1$ - Pyrazosulfuron @ 25 g/ha (20 DAS)** | 40.13 | 73.70 | 98.63 | 105.03 | 35.30 | 78.90 | 59.83 | 68.57 |
| **$W_2$ - Bispyribac sodium @ 25 g/ha (20 DAS)** | 42.93 | 76.90 | 107.27 | 110.80 | 37.43 | 89.63 | 75.43 | 74.97 |
| **$W_3$ - Pyrazosulfuron @25 g + Bispyribac sodium @ 25g (tank mix) (20 DAS)** | 44.50 | 78.90 | 110.57 | 113.00 | 38.93 | 94.57 | 78.40 | 77.33 |
| **$W_4$ - Pendimethalin @1000 g/ha (PE) *fb* $W_3$** | 45.50 | 80.07 | 112.87 | 115.17 | 40.53 | 98.37 | 80.97 | 79.73 |
| **$W_5$ - Weed free (2 Hand weeding at 20 and 40 DAS)** | 46.73 | 81.67 | 115.17 | 117.63 | 41.43 | 101.40 | 84.53 | 82.43 |
| **$W_6$ - Weedy check** | 33.33 | 63.80 | 77.17 | 84.13 | 35.30 | 78.90 | 59.83 | 68.57 |
| **SEm±** | 0.61 | 0.73 | 0.62 | 0.88 | 37.43 | 89.63 | 75.43 | 74.97 |
| **CD (P=0.05)** | 1.76 | 2.08 | 1.79 | 2.55 | 38.93 | 94.57 | 78.40 | 77.33 |
| **Interaction (NXW)** | NS | NS | NS | NS | NS | NS | NS | NS |

**Table.2** Effect of different treatments Plant dry matter production (g/m$^2$) and Crop Growth Rate (g/m$^2$/day)

| **Treatments** | **Plant dry matter production (g/m$^2$)** | | | | **Crop Growth Rate (g/m$^2$/day)** | | | |
|---|---|---|---|---|---|---|---|---|
| | **30 DAS** | **60 DAS** | **90 DAS** | **At harvest** | **30 DAS** | **60 DAS** | **90 DAS** | **At harvest** |
| **Nitrogen levels** | | | | | | | | |
| **$N_1$ - 120 kg N/ha** | 147.66 | 453.06 | 646.69 | 724.33 | 4.92 | 10.18 | 6.45 | 2.59 |
| **$N_2$ - 140 kg N/ha** | 152.95 | 458.65 | 664.58 | 782.00 | 5.09 | 10.19 | 6.86 | 3.91 |
| **$N_3$ - 160 kg N/ha** | 156.10 | 462.40 | 677.52 | 842.50 | 5.20 | 10.21 | 7.17 | 5.50 |
| **SEm±** | 0.34 | 0.32 | 0.40 | 4.47 | 0.01 | 0.02 | 0.01 | 0.14 |
| **CD (P=0.05)** | 1.38 | 1.33 | 1.63 | 18.00 | 0.05 | NS | 0.03 | 0.57 |
| **Weed management** | | | | | | | | |
| **$W_1$ - Pyrazosulfuron @ 25 g/ha (20 DAS)** | 148.47 | 454.90 | 672.83 | 735.33 | 4.95 | 10.22 | 7.26 | 2.08 |
| **$W_2$ - Bispyribac sodium @ 25 g/ha (20 DAS)** | 151.67 | 458.14 | 678.21 | 796.00 | 5.06 | 10.22 | 7.34 | 3.93 |
| **$W_3$- Pyrazosulfuron @25 g + Bispyribac sodium @ 25g (tank mix) (20 DAS)** | 154.51 | 461.65 | 686.31 | 831.67 | 5.15 | 10.24 | 7.49 | 4.85 |
| **$W_4$ - Pendimethalin @1000 g/ha (PE) *fb* $W_3$** | 157.47 | 465.52 | 692.88 | 862.33 | 5.25 | 10.24 | 7.58 | 5.65 |
| **$W_5$ - Weed free (2 Hand weeding at 20 & 40 DAS)** | 161.65 | 468.89 | 700.51 | 900.33 | 5.39 | 10.27 | 7.72 | 6.66 |
| **$W_6$ - Weedy check** | 139.29 | 439.11 | 546.85 | 572.00 | 4.64 | 9.99 | 3.59 | 0.84 |
| **SEm±** | 0.68 | 0.65 | 0.60 | 9.26 | 0.02 | 0.02 | 0.02 | 0.31 |
| **CD (P=0.05)** | 1.96 | 1.77 | 1.74 | 26.88 | 0.07 | 0.06 | 0.08 | 0.91 |
| **Interaction (NXW)** | NS | NS | NS | NS | NS | NS | NS | NS |

**Table.3** Effect of different treatments on yield and its attributes

| Treatments | No. of panicles/m row length | No. of spikelet/panicle | No. of fertile grains/panicle | Grain filling% | 1000-grain weight (g) | Grain yield (q/ha) | Straw yield (q/ha)) | Harvest index (%) |
|---|---|---|---|---|---|---|---|---|
| **Nitrogen levels** | | | | | | | | |
| $N_1$ - 120 kg N/ha | 61.45 | 127 | 113 | 89 | 23.72 | 31.30 | 41.13 | 43.00 |
| $N_2$ - 140 kg N/ha | 67.68 | 133 | 117 | 88 | 24.14 | 33.95 | 44.25 | 43.24 |
| $N_3$ - 160 kg N/ha | 71.41 | 140 | 121 | 86 | 24.65 | 36.22 | 48.03 | 42.92 |
| SEm± | 1.24 | 0.45 | 0.50 | | 0.25 | 0.65 | 0.48 | 0.77 |
| CD (P=0.05) | 5.01 | 2 | 2 | | NS | 2.64 | 1.92 | NS |
| **Weed management** | | | | | | | | |
| $W_1$ - Pyrazosulfuron @ 25 g/ha (20 DAS) | 62.14 | 135 | 116 | 86 | 23.68 | 32.07 | 41.47 | 43.56 |
| $W_2$ - Bispyribac sodium @ 25 g/ha (20 DAS) | 69.33 | 137 | 120 | 88 | 24.01 | 34.93 | 44.67 | 43.89 |
| $W_3$ - Pyrazosulfuron @25 g + Bispyribac sodium @ 25g (tank mix) (20 DAS) | 72.02 | 140 | 122 | 87 | 24.44 | 36.40 | 46.77 | 43.79 |
| $W_4$ - Pendimethalin @1000 g/ha (PE) *fb* $W_3$ | 76.14 | 143 | 124 | 88 | 24.70 | 37.50 | 48.73 | 43.51 |
| $W_5$ - Weed free (2 Hand weeding at 20 and 40 DAS) | 78.22 | 146 | 126 | 86 | 24.85 | 39.07 | 50.97 | 43.44 |
| $W_6$ - Weedy check | 43.22 | 98 | 93 | 95 | 23.33 | 22.97 | 34.23 | 40.14 |
| SEm± | 0.67 | 0.80 | 0.71 | | 0.31 | 0.67 | 0.70 | 0.73 |
| CD (P=0.05) | 1.95 | 2 | 2 | | 0.89 | 1.95 | 2.04 | 2.11 |
| Interaction (NXW) | NS | NS | NS | | NS | NS | NS | NS |

**Table.4** Effect of different treatments on NPK uptake (kg/ha) by Crop, gross return (□ /ha), net return (□ /ha) and B: C ratio

| **Treatments** | **NPK uptake by crop (kg/ha)** | | | **Gross return (□ /ha)** | **Net return (□ /ha)** | **B: C ratio** |
|---|---|---|---|---|---|---|
| | **N uptake (kg/ha)** | **P uptake (kg/ha)** | **K uptake (kg/ha)** | | | |
| **Nitrogen levels** | | | | | | |
| **$N_1$ - 120 kg N/ha** | 58.88 | 10.18 | 52.00 | 52,360 | 23,927 | 0.84 |
| **$N_2$ - 140 kg N/ha** | 64.58 | 12.24 | 57.70 | 56,720 | 27,989 | 0.97 |
| **$N_3$ - 160 kg N/ha** | 70.29 | 14.82 | 64.30 | 60,672 | 31,645 | 1.09 |
| **SEm±** | 0.70 | 0.14 | 1.66 | 855 | 855 | 0.03 |
| **CD (P=0.05)** | 2.82 | 0.56 | 6.68 | 3446 | 3446 | 0.12 |
| **Weed management** | | | | | | |
| **$W_1$ - Pyrazosulfuron @ 25 g/ha (20 DAS)** | 60.04 | 10.10 | 52.51 | 53507 | 27789 | 1.08 |
| **$W_2$ - Bispyribac sodium @ 25 g/ha (20 DAS)** | 66.12 | 12.27 | 57.84 | 58189 | 32446 | 1.26 |
| **$W_3$ - Pyrazosulfuron @25 g + Bispyribac sodium @ 25g (tank mix) (20 DAS)** | 69.27 | 13.65 | 61.75 | 60677 | 34059 | 1.28 |
| **$W_4$ - Pendimethalin @1000 g/ha (PE) *fb* $W_3$** | 72.35 | 14.65 | 65.17 | 62622 | 34338 | 1.21 |
| **$W_5$ - Weed free (2 Hand weeding at 20 and 40 DAS)** | 76.37 | 16.17 | 69.10 | 65277 | 24106 | 0.59 |
| **$W_6$ - Weedy check** | 43.36 | 7.65 | 41.64 | 39230 | 14386 | 0.58 |
| **SEm±** | 1.06 | 0.41 | 2.93 | 945 | 945 | 0.03 |
| **CD (P=0.05)** | 3.09 | 1.19 | 8.51 | 2741 | 2741 | 0.10 |
| **Interaction (NXW)** | NS | NS | NS | NS | NS | NS |

An experiment under split plot design replicated thrice, was conducted at University Research Farm of Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar during rainy season of 2016 to study the "Effect of weed management and nitrogen on weed dynamics and yield of rice under aerobic condition". The highest growth and yield attributes of rice were recorded under 160 kg N/ha which was significantly superior to other nitrogen levels however, the highest grain yield of rice was recorded under 160 kg N/ha which was statistically at par with 140 kg N/ha and significantly superior to 120 kg N/ha. The highest net return was recorded by treatment 160 kg N/ha which was significantly superior to other nitrogen levels. The highest value of Benefit: Cost ratio (1.09) was obtained under 160 kg N/ha which was significantly superior to 140 kg N/ha & 120 kg N/ha. So, it may be concluded that application of 160 kg N/ha can give better return in terms of yield as well as in economics too in rice under aerobic condition.

## Acknowledgement

The authors gratefully acknowledge Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar for providing financial assistance and infrastructural facilities.

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**How to cite this article:**

Neha Nandan, D. K. Roy, Shashank Kumar and Ashok Kumar. 2020. Effect of Nitrogen on Growth, Yield and Nutrient Uptake of Rice under Aerobic Condition. *Int.J.Curr.Microbiol.App.Sci.* 9(02): 2025-2035. doi: https://doi.org/10.20546/ijcmas.2020.902.231