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Effect of nitrogen fertilization on rice: A review

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Abstract
Nitrogen is play a major role in the production and productivity of rice**.** The rate of nitrogen fertilizer application is strongly influence the rice yield. The management of nitrogenious fertilizer in rice field is a major challenging task for farmers because of various kinds of losses of nitrogen in rice field such as denitrification, deep percolation and run-off in flooded soils resulting in low nitrogen use efficiency which leads to low yield of rice in India. Therefore, it will be advisable to optimize the use of nitrogenous fertilizers for getting high yields and keeping the cost of production at sustainable level. In the above context there is need to use nitrogenous fertilizer more efficiently and judiciously for rice production. According to several studies conducted in rice by the scientists in India and other Asian rice-growing countries revealed that, nitrogen has a positive influence on growth and yield attributes**,** and yield of rice.

Keywords: Nitrogen management, rice yield, nitrogenous fertilizers

Introduction
Rice is one of the most important cereal crops' of the world. Presently more than 90% of total rice production and consumption in Asia. In India, area under cultivation of rice is around 44 m ha and production of 109.70 million tonnes during 2016-2017 (Anonymous, 2018) [1]. World's rice demand is projected to increase by 25 percent from 2001 to 2025 to keep pace the population growth and therefore, meeting ever-increasing rice demand in the sustainable way with shrinking natural resources are a great challenge (Singh *et al*., 2016) [33].
During past few decades, rice production increased mostly due to adoption of high yielding nitrogen responsive rice varieties, increase in irrigated area and use of chemical fertilizers. However, the rate of increase in rice yield is static and if the rate is not possible to increase, severe food shortage is likely to occur in the near future. So rice production can be increased by good nitrogen management practices because, it is the indispensable nutrient to rice production and its uptakes is influenced by rice varieties, environment, soil conditions and crop rotations etc. In general, about 10-12kg of rice is obtained per every kg of applied nitrogen however, magnitude of response varies with season, soil characteristics, variety and cultural practices (Pillai *et al*., 1976) [28]. In the field of rice under these conditions are saturated, flooded, and anaerobic and N use efficiency is low. Under these situations, increasing rice yield per unit area through use of appropriate N management practices have become an essential component of modern rice production technology (Fageria and Baligar, 2001) [8]. Therefore, this review paper is showing the impacts of nitrogen management practices on various aspects of growth and development of rice.

Effect of Nitrogen Level on Growth Attributes of Rice
The growth of rice is mainly pertains to two aspect i.e. dry matter production and quantitative changes during the development stages. Both the aspects are sensitive to the proper nutrient supply. Water and nutrients have been considered to be essential for plant growth and development. But, among the all nutrient nitrogen is major nutrients for which soil are in general deficient and needs to be feeded from outside for proper growth and development of the rice crop.
Somasundaram *et al*. (2002) [35] observed that significant increase in leaf area index with each successive increase in N level from 0 to 150 kg/ ha in contrast N 100 to 150 kg/ha did not significantly improve the above parameters. However, the maximum values for growth parameters were recorded at 125 kg N/ha. Meena *et al*. (2003) [20] conducted an experiment and reported that application of 180 Kg N/ha resulted in higher plant height of rice. Mohapatra *et al*. (2004) [22] observed that significant increase in days to 50% flowering with the increasing the nitrogen levels from 0 to 60 kg/ha. Murali and Shetty (2004) [24] conducted an experiment

and reported that every 50 kg increment in the N dose from 0 to 150 kg/ha significantly enhanced the dry weight/hill and duration of scented rice at Kanpur. Murali and Shetty (2004) [24] conducted an experiment and reported that higher leaf area index (4.71) with application of 150:75:75 NPK kg/ ha as compared to application of 125:62.5:62.5 and 100:50:50 NPK kg/ ha. Balasubramaniyan and Palaniappan (2005) concluded that nitrogen play a vital role in a living plant tissues and is a constituent of protein, enzyme, hormone, vitamins alkaloids chlorophyll etc. Maqsood *et al*. (2005) [19] observed that nitrogen play a vital role in influencing the growth and development of rice plant and significant improvement in plant height was observed up to application of 150 kg/ha, which resulted tallest plant where as 125kg/ha recorded highest leaf area index. Mhaskar and Thorat (2005) [21] also found increase in plant height with increase in N level from 0 to 120 kg/ha and they also noticed increase in number of tiller/m2 and number of functional leaves/m2 with increase in N level from 0 to 120 kg /ha.

Manzoor *et al*. (2006) [15] found that plant height show increasing trend with increasing nitrogen level 0-175kg. Salem (2006) [30] conducted an experiment and reported that higher leaf area index with 70 kg dose of N at the Egypt. Sharief *et al*. (2006) [34] conducted an experiment and reported that maximum plant height, flag leaf and number of tiller/m2 were produced from increasing nitrogen fertilizer level up to 150 kg/ha. Increasing nitrogen fertilizer level from 40 to 120 or 150 kg N/ha increase flag leaf area by 26.6 and 14.38%, plant height by 11.82 and 4.90 and number of tiller/m2 by 43.47 and 22.27. Mannan *et al*. (2010) [18] reported that plant height and tiller number increased with the increase of nitrogen levels at different growth stages at 30, 45, 60 day after transplanting and at maturity, plant height and higher number of tillers were observed at higher levels of nitrogen the tillers increased proportionally with the increase of nitrogen levels. Awan *et al*. (2011) [2] conducted an experiment and reported that nitrogen application of 156 kg N/ha with spacing of 22.5 cm showed maximum values of plant height (79.07cm), tillers/m2 (594). Murty *et al*. (2012) noted that significant increase in plant height and LAI at flowering with increasing nitrogen level up to 120 kg N/ ha. Malik *et al*. (2014) [25] conducted an experiment and reported that the maximum number of tillers was found in the variety Pusa Basmati -1 (19.29) at level (140 kg N/ha) followed by Haryana Basmati-1 (18.60) at level (140 kg N/ha). Haque *et al*. (2016) reported the application of 60 kg N/ha increased panicle/hill, grains/panicle, filled grains/panicle and seed size which ultimately increased the yield of the rice variety and dry matter translocation from vegetative to reproductive organ increased with increased nitrogen levels up to 60 kg N/ha and lowest crop growth rate (25.96 g/m2/day) was recorded at 85 days after transplanting when crop was fertilized with 100 kg N/ha. He also reported that application of 60 kg N/ha also showed the highest nitrogen use efficiency (344.50 kg grain/kg N applied) of the variety.

Effect of Nitrogen Level on Yield Attributes and Yield of Rice

Bhowmick and Nayak (2000) conducted an experiment and reported that, increase in grain weight at higher nitrogen rates might be primarily due to increase in chlorophyll content of leaves which led to higher photosynthetic rate and ultimately plenty of photosynthates available during grain development. Dwivedi and Pandey (2000) studied an effect of N scheduling and agro inputs on grain yield and N uptake a hybrid rice. N applied in field experiment 50% basal +25% tillering +25% Panicle initiation gave second highest resulted, grain yield (53.22 q/ha) and N uptake (87.75kg/ha).Murali and Setty (2001) [23] conducted an experiment and reported that at Bellary showed that scented rice, Pusa Basmati-1 responded significantly to the application of 150:75:75 kg NPK/ha with increase total dry matter production, number of panicles /m2, filled grain/ panicle and grain yield. Das *et al*. (2003) reported that increasing levels of N application influenced the total N uptake at harvest of both rice and wheat, giving the highest values under 100% N level. Application of higher doses of N might have increased the N content in grain and straw of rice and wheat crop. Higher N content at higher level of N application together with higher dry matter production resulted higher N uptake. Similarily Jadhav *et al*. (2003) [13] also observed that decreased kernel length after cooking with higher levels of nitrogen application (0 to 150 kg/ha). Nitrogen fertilization resulted in significant increase in rice recovery, length and breadth of kernel up to 100 kg/ ha, while protein content and sensory aroma of cooked rice were improved up to 150 kg N/ha. L: B ratio was not affected by nitrogen. Mural and Shetty, (2004) [24] reported that grain yield of inbred and hybrid aromatic rice increased significantly at each successive level of nitrogen. The yield increase was 34 and 11.8 per cent and 35 and 6.5 per cent for 160 kg N/ha over 0 and 80 kg/ha respectively.

Pandey and Nandeha (2004) [26] concluded that application of chemica fertilizers @ 120 kg N/ha produced significantly higher grain yield of scented rice during both the years. Sahu *et al*. (2004) [29] reported that the seed yield of Indira Sugandhit Dhan-1 on plot basis was highest under higher fertilizer dose (100 kg N/ha) and close spacing (10 x 15 cm). Gautam *et al*. (2005) [10] reported that each successive increase in the level of nitrogen significantly increased the grain yield of aromatic rice. The magnitude of yield increase was 34.0 and 11.8 percent and 35.0 and 6.5 percent for 160 kg N/ ha over 0 and 80 kg N/ ha respectively. Maqsood *et al*. (2005) [19] reported that the application of 125 kg N per/ha produced highest number of productive tillers/ m2, 1000 grain weight, harvest index and subsequently the yield of fine rice. Mhaskar and Thorat (2005) [21] reported that significant increase in the yield attributes such as, panicle length, number of total grains/panicle, per cent filled grains/panicle, weight of filled grains/panicle (g), weight panicle/hill, 1000 grain weight (g) and grains/panicle with the application graded levels of N from 0 to 120 kg/ha. Mhaskar and Thorat (2005) [21] obtained significantly highest grain yield with the application of 120 kg N/ha (4.2 t/ha) which was 15, 43, and 91 per cent more over 80, 40 and 0 kg N/ ha. Same trend was also recorded with straw yield. Paraye *et al*. (2006) revealed that application of 50% RDF (40 kg N/ ha for Madhuri and Kasturi and 30 kg N/ha for Dubraj) recorded higher yield attributes (number of grains/panicle and test weight of seeds) and yield (grain +straw) of rice as compared to that of 100% RDF alone. They also found that the treatment 100% RDF (100 N/ha) to Pusa Basmati-1 recorded the highest yield (grain + straw), which was at par with the treatment Eupatorium 75 t/ha-with 50% RDF Sharief *et al*. (2006) [34] conducted the experiment and result indicated that maximizing grain yield and its quality as well as reducing environmental pollution by addition nitrogen fertilizer at a rate of 120 kg N/ha.

Mankotia *et al*. (2007) [17] conducted an experiment and reported that the application of 100% RDF produced 295 effective panicles/ m2, with mean panicle weight of 2.28 g,

and that of 50% RDF gave 288 and 2.27, respectively. The increase in fertility level from 50% to 100% increased the rice grain yield (0.36 t/ ha; 8.3%) and straw yield significantly. Application of 150% fertility level recorded higher values of grain (4.85 t/ ha) and straw yields, but remained at par with that of 100% fertility level. Singh *et al*. (2007) [32] reported that grain yield of rice significantly increased with application of N up to 120 kg/ ha applied N increased the grain yield by 62% as compared to control. Srinivasan *et al*. (2007) [36] reported that taking different nitrogen levels (0,100,150,200 kg/ha) that response of nitrogen was noticed up to 150 kg N/ha with respect of grain yield. Mahajan *et al*. (2009) reported that, grain yield increased significantly with increase in N application rate from 120 to 150 kg/ha and further increase in N rate above 150 kg/ha did not increase the grain yield significantly. Mannan *et al*. (2010) [18] reported that straw yield increase significantly with the nitrogen rates up to 75 kg N/ha. There was no significant difference in straw yield between 75 and 100 kg N/ha, but 100 kg N/ha showed higher straw yield than other levels of nitrogen. The vigorous crop growth for the nitrogen treatments might have resulted in higher straw yields of fine rice. Awan *et al*. (2011) [2] reported that nitrogen application of 156 Kg N/ha with the spacing of 22.5 cm shows maximum values of plant panicle length (25.40cm), no of grains/panicle (132.97), grain yield (5461.03 Kg/ha), plant straw yield (9662.03 panicle length (25.40cm), no of grains/panicle (132.97), grain yield (5461.03 Kg/ha) and least value of sterility percentage (5.7%). Hirzell *et al*. (2011) [12] conducted an experiment and reported that N rates and obtained the highest grain yield with 120 to 160 N kg/ha suggesting that 120 N kg/ha rate is adequate dose for rice crop.

Banerjee and Pal (2012) [4] noted that different yield attributes viz. number effective tiller/m2, panicle length, filled grains/panicle, and test weight increased significantly with increasing level of nitrogen from 50-150kg/ha. Mahajan and Timsina (2012) [16] conducted an experiment and reported that spikelet sterility increased by 22% at higher N level (180 kg/ha) as compared to lower level of 120 kg N/ha. Murthy *et al*. (2012) conducted an experiment and reported that increasing levels of nitrogen progressively enhanced number of filled grains/panicle/ha, grain and straw yields of rice only up to 120 kg N/ha. Haque *et al*. (2016) [11] concluded that highest number of panicle/hill (8.8), number of panicle/hill, highest number (100.11) of filled grains/panicle, grains (118.31)/panicle and highest grain yield (5.36 t/ha) was found when the crop was fertilized with 60 kg N/ha as compare other treatments.

Effect of Nitrogen Level on Nutrient Uptake and Content of Rice

Sarabdeep Kaur *et al*., (2005) [31]. Reported significant increase in the uptake of N, P, K and Zn with each successive increment of nitrogen from 0 to 180 kg/ha. Mannan *et al*. (2010) [18] revealed that nitrogen uptake in grain and straw increased with increment of nitrogen levels up to 100 kg/ha, where the application of nitrogen promoted the concentration of nitrogen in plant. The rate of N-uptake in grain was the lowest in the N control plots. Ganga Devi *et al*. (2012) [9] found increase in the N, P and K uptake (kg/ha) with the increase in the N level from 100 to 175 kg/ha and 0 to 150.

Conclusion

Effect of nitrogen fertilization on rice in India and other Asian rice-growing countries, it has been suggested and already proved that the nitrogen levels had significant effects on growth and development of rice crops yield. However, the application of nitrogen has significantly effects on chlorophyll content and net photosynthetic rate due to active role in the biosynthesis of chlorophyll. Further, it proved that the N fertilization significantly enhanced the N uptake by rice crop and showed a higher N content in the rice grain. The quality of rice grain was also enhanced by N fertilization. Hence nitrogen fertilization are very vital for rice production and its deficiency in soil may cause significant reduction in rice grain yield. Finally it was concluded from this study that application of nitrogen in various doses has increased overall productivity of rice by increased nitrogen use efficiency.

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