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Influence of Different Planting System and Levels of Nitrogen on Growth, Yield, Quality and Economics of Rice (*Oryza sativa* L.) - A Review

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ABSTRACT

Cereals are the member of grasses, which belong to family *Gramineae* (*Poaceae*) and cultivated for edible components of their grain which is composed of the endosperm, germ and bran. Cereal grains are grown in greater quantities and provide more food energy worldwide than any other type of crop. In their natural form, they are a rich source of carbohydrates, protein, vitamins, minerals and fats. The green revolution of the 1970s resulted in remarkable increases in rice production. Since then the rate of production in most rice growing countries has slowed and has now reached a plateau. Contributing factor include a higher population growth rate and the conversion of some highly productive rice land for industrial and residential purpose. Millions of hectares in the humid regions of south and Southeast Asia are technically suited for rice production but are technically suited for rice production but are left uncultivated or are grown with very low yields because of salinity and abiotic stresses. Many research findings revels that System of Rice Intensification followed by 120 kg Nitrogen ha^{-1} has significantly perform better than all others planting system & levels of nitrogen for various growth, yield & quality attributes viz; Number of effective tillers hill^{-1} (18.59), Number of grains panicle^{-1} (108.88), Length of panicle (27.90 cm), Test weight (24.82 g), Grain yield (5.34 t ha^{-1}), Straw yield (10.26 t ha^{-1}), Harvest index (34.23 %) and Protein content (8.37 %). While the same combination also found prominent to obtain highest gross return (152600.00 Rs ha^{-1}), net return (92077.92 Rs ha^{-1}) and B: C ratio (2.52) respectively. This review article throws light on some important aspects on influence of different planting system and graded levels of nitrogen on growth, yield, quality and economics of rice (*Oryza sativa* L.). References from various research articles and literature were compiled systematically with respect to the topic. Evidence based research studies were also reviewed in this regard.

Introduction

Rice belongs to genus *Oryza* and the family Gramineae (Poaceae). The genus Oryza contains 25 recognized species, of which 23 are wild species and two cultivated (*O. sativa* and *O. glaberrima*). Rice is the staple food for more than 60% of the Indian population. Rice is India's pre-eminent crop, covering about one-fourth of the total cropped area and providing food to about half of the Indian population. In Asia alone, more than 2,000 million people obtain 60 to 70 per cent of their calories from rice and its products. Rice is mostly grown under submerged soil conditions and requires much more water compared with other crops. It accounts for about 43% of total food grain production and 46% of total cereal production in the country Anonymous *et al.,* (2006). More than 90 per cent of the world's rice is produced and consumed in Asia, where it is an integral part of culture and tradition. Rice occupies a pivotal place in Indian agriculture and it is contributes to 15 per cent of annual GDP and provides 43 per cent calorie requirement for more than 70 per cent of Indians Anonymous *et al.,* (2005). India has 44.14 million hectare area under rice and production of 106.65 million tonnes with an average yield of 2416 kg ha^{-1} during 2013-14 (GOI (2015). Uttar Pradesh has an area of 5.98 m ha, production of 14.64 million tonnes and productivity of 2.447 t ha^{-1} of rice GOI (2015). It is estimated that 5000 liters of water is needed to produce 1 kg of Rice Bouman *et al.,* (2009).

Manual transplanting is the most common practice of rice cultivation in south and south-east Asia. In recent years, water table is running down at a very rapid rate throughout the globe, thus sending an alarming threat and limiting the scope for cultivation of high water requiring crops very seriously. Rice being a crop having high water requirement, there is a need to search for alternative methods to reduce water requirement of rice without reduction in yield. Changes in crop establishment have important implications for farm operations, including primary tillage, seedbed preparation, planting, weeding, and water management that have a considerable impact on rice growth, especially seedling development and rice canopy structure establishment. Using a mechanical transplanter, seedlings are transplanted at uniform depth and spacing, thereby establishment of seedlings is faster and more number of tillers are produced (16.8 tillers $hill^{-1}$) which result in 30-35 per cent higher yield compared with hand transplanting Saha and Bharti (2010). Similarly Tiwari *et al.,* (2003) reported that by using eight row self-propelled rice transplanter save 68 per cent of labour compared to manual transplanting. The self-propelled eight row paddy transplanter saves 30 mm day ha^{-1} and eliminated drudgery on the part of laborers with the area of 1.5 ha in a day of 8 working hours Manjunatha *et al.,* (2009). During the last two decades or so, a new approach, widely known as System of Rice Intensification (SRI), has attracted attention because of its apparent success in increasing rice yield. This system was introduced in India during the year 2000 as a viable alternative of rice cultivation that enhances the productivity while minimizing the inputs. Uphoff *et al.,* (2002) Noticed that nutrient management must be sound for achieving yield potential of rice under System of Rice Intensification. SRI is a technique comprised of a set of practices and principles rather than as a "technology package" Uphoff *et al.,* (2004). SRI is not a technology like that of high yielding varieties or a chemical fertilizer or insecticide. It is a system for managing plants, soil, water or nutrient together in mutually beneficial ways and creating synergies. System of Rice Intensification and management practices control or modify the microenvironment so that existing genetic potentials can be more fully expressed and realized. Nitrogen is a key component of many organic compounds. In the absence of applied nitrogen, the crop yield should be limited by the available nitrogen within the soil. Nitrogen application can improve the root system, so that water and nutrient absorption are facilitated. Yoshida *et al.,* (1972) reported that nitrogen plays an important role in developing yield capacity and maintaining the photosynthetic activity during grain filling stage of the crop. Nitrogen application can improve the root system, so that water and nutrient absorption are facilitated and rice production and productivity was significantly enhanced with the introduction and cultivation of semi-dwarf, fertilizer responsive and non-lodging high yielding varieties in the early seventies leading to the "Green Revolution". Hence, efficient use and management of nitrogen in crop production is critical for obtaining optimum crop productivity, quality, environmental safety and economic returns. The objective of this study is to find the response of different planting system and graded levels of nitrogen on growth, yield, quality and economics of rice (*Oryza sativa* L.). The research prospects of this article will be helpful In future, it is important to develop the model and equipment of rice seedling and transplanting in different season and hybrid rice transplanting progress. Especially improve the technology of precision sowing, seedling gap filling, and seedling transplanting. In addition, it is necessary to improve the machine technology of fertilization, spraying, and weeding, and it is efficiently for rice production to combine the transplanting and fertilization. With the development of large-scale rice planting, it is important to invent the factory seedling progress, and socialized service system. In south India it is useful for double season, and single season rice seedling breeding, but it is small scaled nowadays. Seedling breeding technology for social service is further developing for rice production intensification and modernization.

Different planting system on growth, yield, quality and economics of rice

System of rice intensification

The SRI method of rice cultivation involves planting single seedling in wider row spacing i.e. 25x 25 cm, which involves more labour intensive and laborious process. Mechanical equipments for various farm operations are generally being used by the farming community. Even small farmers are adopting and utilizing selected farm equipments for efficient farm management through custom hiring. Transplanting, weeding and harvesting are the major operations that consume most of the labour requirement in rice cultivation. Mechanization with SRI methods leads to maintain plant-to-plant spacing and reducing seedling age, reducing the seed requirements by 50%, labor requirements reduction by 60%, and the time required for all of the main rice-farming activities by 70%. High labour demand during peak periods adversely affects timeliness of operation, thereby reducing the crop yield. Usage of tools, implements and machineries for puddling, transplanting, weeding and harvesting will lead to reduction in drudgery, cost and time. In SRI method the nursery was raised in raised bed and fourteen days old seedlings were planted at a spacing of 25 x 25 cm. Saina *et al.,* (2001) reported in his research trial that SRI practice 50 tillers plant^{-1} were easily obtained, and farmers who had mastered the methods and understand the principles were able to get over 100 tillers from single tiny seedling. Grain and straw yields were the highest (5.6 and 5.98 t ha^{-1}) in SRI planting method.

The highest grain yield of SRI planting method was mostly the outcome of higher total number of tillers hill^{-1}, highest panicle length and highest number of grains panicle^{-1}. Conventional planting method produced the lowest grain and straw yields (3.65 and 4.29 t ha^{-1}) respectively Hossain *et al.,* (2003). The grain yield and water productivity were significantly increased at SRI planting with 14 days dapog seedlings planted at 25 x 25 cm spacing to achieve 7009, 5655 kg ha^{-1} and 0.610 kg and 0.494 kg m^{-3} of water respectively in wet and dry season Vijayakumar *et al.,* (2006). SRI method of cultivation, application of FYM and RDF significantly increased the number of tillers.

The treatment combinations with SRI method showed more number of productive tillers. Under SRI method, the days to 50% flowering and maturity were four to five days earlier compared to traditional method. 12 days old seedlings with wider spacing recorded significantly higher germination and vigour index values Krishna *et al.,* (2008). Similarly findings are revealed by Rajeshwar and Khan (2008) in his experiment reported that highest grain yield of 6735 and 6125 kg ha^{-1} and water use efficiency of 6.75 and 6.25 kg ha^{-1} mm was recorded with green manuring and FYM under the SRI method of planting compared to the conventional method (6467 and 6053 and 4.50 and 4.25 kg ha^{-1}mm). The combined effect of reduction in cost and higher yield has resulted in increase in net return to the extent of over 31%. The average cost of production (paid out cost) has been worked out to be ₹ 269 q^{-1} of rice under SRI practice and ₹ 365 q^{-1} under normal practices, an advantage of 26% in cost of production Barah *et al.,* (2009).

Maximum total grain productivity (13750 kg $ha^{-1}yr^{-1}$), total fodder productivity (14864 kg ha^{-1} yr^{-1}), net profit (₹ 79,912 ha^{-1} yr^{-1}), gross returns (₹ 1,17.432 ha^{-1} yr^{-1}), B:C ratio (2.13), total tillers (412m^{-2}) and effective tillers (343 m^{-2}) were recorded with SRI method of paddy cultivation Hugar *et al.,* (2009). The crop raised with SRI technique receiving recommended NPK + FYM at 10 t ha^{-1} registered yield superiority of 15.47 and 19% over farmers practice during 2006 and 2007 respectively Hussain *et al.,* (2009). The considerable increase in rice productivity and farmer incomes, which is being achieved in Andhra Pradesh with substantial reduction in irrigation water application (162.3%), labour and seed costs through utilization of SRI method of transplanting. Potential public savings on water (51.5%) and power costs could be drawn upon not only for promoting SRI method of transplanting but also to effect systemic corrections in the irrigation sector, to mutual advantage Adusumilli *et al.,* (2010). Similarly Barah *et al.,* (2010) projected that the return to SRI is reasonably high at ₹ 14875 to ₹ 17629 ha^{-1} (equivalent to US$ 309 to US$ 370) across the districts as compared to corresponding figure of ₹ 9263 to ₹ 14564 (US$ 192 to US$ 303) under conventional practices. Manjunatha *et al.,* (2010) observed in research trial that younger seedlings of 9 days (6.07 t ha^{-1}) and 12 days (6.01 t ha^{-1}) produced significantly higher grain yield than other aged seedlings, *viz.,* 15 days (5.79 t ha^{-1}), 18 days (5.77 t ha^{-1}) and 21 days (5.78 t ha^{-1}). Modified SRI method of transplanting resulted in significantly higher grain yield (6.34 t ha^{-1}) when compared to other methods, *viz.,* normal method (5.10 t ha^{-1}) and recommended SRI method of transplanting (6.21 t ha^{-1}).

The experimental trial on rice conducted by Thakur *et al.,* (2010) reported that performance of individual hills was significantly improved with wider spacing compared with closer spaced hills in terms of root growth and xylem exudation rates, leaf number and leaf sizes, canopy angle, tiller and panicle number, panicle length and grain number $panicle^{-1}$, grain filling and 1000 grain weight and straw weight, irrespective of where SRI was employed. SRI yielded 40% more than the recommended practice. Priya *et al.,* (2010) reported that adoption of SRI recorded 638 number of productive tillers m^{-2}which was significantly higher than that of conventional method of rice cultivation (507). The length of panicle and numbers of grains $panicle^{-1}$ were also significantly higher under SRI than farmer's practice of rice cultivation. SRI registered 218 grains $panicle^{-1}$ and 22.6 cm length of panicle. SRI registered a mean grain yield of 6082 kg ha^{-1} which was significantly higher than conventional method of rice cultivation (5223 kg ha^{-1}). Thus significant superiority of SRI in terms of grain yield was evident due to 17.0 per cent yield increment by SRI. Veeraputhiran *et al.,* (2008) also obtained 23.1 per cent yield improvement by SRI than farmers practice in Tamirabarani Command areas of Southern Tamil Nadu. The higher yield attributes like number of productive tillers m^{-2}, length of panicle and numbers of grains $panicle^{-1}$ attributed the higher grain yield of SRI. These results of higher grain yield with SRI collaborate with the findings of Makarim *et al.,* (2002) and Ganesaraja *et al.,* (2008). Similar results of higher yield attributes with SRI than conventional method were confirmed by (Kumar *et al.,* (2002). Labour requirement for weeding was less in the cono-weeded plots denoting lower cost of cultivation in SRI compared to other practices Anitha and Chellappan (2011).

System of rice intensification is a boon for small and marginal farmers as it reduced input cost of seeds by 60% and irrigation water cost by 40%, reduced fertilizer cost by 30% and enhanced production by 35% over the traditional transplanted rice Karmakar *et al.,* (2011). SRI practices showed significant response on root number, number of effective tillers $hill^{-1}$, days to flowering and harvest index Chapagain *et al.,* (2011). The management factors followed in SRI method of cultivation produced significantly more number of panicles m^{-2} and number of grains $panicle^{-1}$, the yield was increased significantly by 18.6% when compared to conventional practices Prabha *et al.,* (2011). In SRI method of transplanting recorded an additional grain yield 2.76 t ha^{-1} over normal transplanting (NTP) method due to more number of filled grains $panicle^{-1}$ and better partitioning harvest index Sowmya *et al.,* (2011). Similarly findings are given by Dass and Chandra (2012) reported that grain yield was 16.9% higher under SRI compared to conventional method (5.22 t ha^{-1}). The experiment carried out on rice by Reddy *et al.,* (2013) conclude that growing rice under SRI with 100% NPK recorded significantly higher mean grain yield of 76.56 q ha^{-1} than transplanting with a grain yield of 64.76 q ha^{-1}, resulting in a yield increase of 15%. Shukla *et al.,* (2014) recorded significantly higher growth attributes with transplanting of younger age seedling (10 days), *viz*. plant height, number of green leaves $hill^{-1}$, dry matter accumulation with yield attributing characters. Similar results were confirmed by Duttarganvi *et al.,* (2014) reported that significantly higher tillers $hill^{-1}$ (29), root length (31 cm), leaf area $hill^{-1}$ (319 cm^2), panicles $hill^{-1}$ (24) and grain yield (5.63 t ha^{-1}) were recorded under SRI as compared to Normal Traditional Planting (NTP). The experiment finding of Pyngrope *et al.,* (2017) revealed that SRI + 120 kg Nitrogen ha^{-1} significantly performed better than all other treatments viz; Number of effective tillers $hill^{-1}$ (18.59), Number of grains $panicle^{-1}$ (108.88), Length of panicle (27.90 cm), Test weight (24.82 g), Grain yield (5.34 t ha^{-1}), Straw yield (10.26 t ha^{-1}), Harvest index (34.23 %) and Protein content (8.37 %). SRI + 120 kg Nitrogen ha^{-1} recorded highest gross return (152600.00 Rs ha^{-1}), net return (92077.92 Rs ha^{-1}) and B: C ratio (2.52), however treatment (MTR + 120 kg Nitrogen ha^{-1}), SRI + 60 kg Nitrogen ha^{-1}, SRI + 90 kg Nitrogen ha^{-1} and SRI + 120 kg Nitrogen ha^{-1} were statistically at par with treatment SRI + 120 kg Nitrogen ha^{-1} respectively Pyngrope *et al.,* (2018)

Conventional transplanted rice

Conventional paddy cultivation involves transplanting of seedlings in puddle fields performed by labours predominantly by women labours. Transplanting method involves seedbed preparation, nursery growing, care of seedlings in nursery, uprooting of seedlings, hauling and transplanting operations. The preparation of seedbed and sowing are done 30 days before planting. The rice farmers practicing transplanting are facing problems like shortage of labour during peak time, hike in labour charges, small and fragmented land holdings etc. The land was prepared conventionally and final land preparation was done by ploughing and cross ploughing by two wheel power tiller with two laddering before two days of transplanting. Raised bed and furrows were made manually by spade following the conventional land preparation. The crop was fertilized with N, P, K, S, and Zn at the rates of 100, 60, 40, 10, and 5 kg ha^{-1}, respectively. In conventional method of rice cultivation, use of a seed rate of 30-60 kg ha^{-1} in 1000 m^{-2} nursery area, seedling age 21-30 days with 15 x 10 to 20 x 15 cm, irrigation 5 cm depth one day after disappearance of pounded water and manual weeding twice at 15 and 30 DAT were practiced.

Machine transplanted rice

Looking towards the labor shortage in the farm operations, government promotes mechanization in all the possible way to make the farming profitable. Due to small land holding and weak economic position, farmers are not in a position to purchase the machine individually, but on hiring basis the technology should be adopted. The mechanical transplanters are classified on the basis of nursery used i.e., machine using wash root seedling and machine using mat type seedlings. About 40% of the total energy requirement in mechanical transplanting was required in mat nursery preparation while energy share for traditional nursery under manual transplanting was only 11 % Baruah *et al.*, (2001). Mat type seedlings are raised on a polythene sheet with the help of frames. 20-30 days old seedlings were found most suitable for transplanting. The mat thickness for best results should be about 2 cm. Transplanting mat type seedling is becoming more popular due to its superior performance and reduced labor requirement of 50 man ha^{-1} Dixit *et al.*, (2012). The use of self-propelled transplanter gives economic benefits to the farmers over the manual transplanting methods. The average net returns were Rs. 19,798.00 ha^{-1} and Rs. 27,462.00 ha^{-1} in traditional and self-propelled paddy transplanting methods of paddy cultivation, respectively Singh and Rao (2012). The self-propelled rice transplanter gave net profit of Rs 1146.00 and Rs 1319.00 per ha when annual use of machine was 300 h (one season) and 500 h (two seasons), respectively, over the manual transplanting and the payback period for investment on the transplanter was 10.23 years and 1 year when annual area covered was 20 and 80 ha, respectively Chaudhary *et al.*, (2005). The mechanical transplanting significantly increased grain yield about 23, 37 and 63 %, straw yield about 17,14 and 22 % and biological yield about 20, 24 and 39 % over manual transplanting, dry direct seeding and direct seeding of sprouted rice in puddled conditions, respectively Singh *et al.*, (2006). Grain yield increased with self-propelled walk behind type (9.3%) and self-propelled four wheels type (6.7%) transplanters over farmers practice Manesh *et al.*, (2013). The seed rate 110 g/mat and mat moisture of 20-25 % are suitable for mats and 25-30 days nursery is best suitable for transplanting Dixit *et al.*, (2007). Hence, the present study was conducted with an objective to compare the response of different planting system and graded levels of nitrogen on growth, yield, quality and economics of rice (*Oryza sativa* L.). Grain yield in both manual and mechanical transplanting remained on par with mean grain yield of 53.77 and 54.01 q ha^{-1}, respectively. The field capacity, field efficiency and fuel consumption of the transplanter were 0.19 ha hr^{-1}, 78% and 6.25 l ha^{-1}, respectively. Cost of mechanical transplanting was (₹ 789 ha^{-1}) as compared to

(₹ 1625 ha^{-1}) in case of manual transplanting provided the machines are used for their maximum usage of 90 hectares in a year Manjunatha *et al.,* (2009).

Machine transplanted basmati rice (*Oryza sativa* L.) after puddling being statistically at par with direct seeding methods, showing significantly higher values of growth and yield attributes. Yield attributes like panicle length (26.7 cm) and test weight (21.6 g) were statistically at par among different methods of establishment, but grains 141.1 $panicle^{-1}$ was significantly higher with machine transplanted basmati rice after puddling. Machine transplanted rice after puddling gave more grain yield (3.3 t ha^{-1}) over direct-seeded basmati rice with brown manuring (3.3 t ha^{-1}), direct seeded basmati rice without brown manuring (3.2 t ha^{-1}), conventional transplanted rice (3.2 t ha^{-1}), machine transplanted rice in zero-tilled plots with brown manuring (3.2 t ha^{-1}) and machine transplanted rice in zero tilled plots without brown manuring (3.1 t ha^{-1}) Gill and Walia (2013). The research trial conducted by Kamboj *et al.,* (2013) on rice to find the performance among different planting methods and output of experiment revels that in comparison with conventional puddled transplant rice (CPTR), mechanical transplanted rice (MTR) produced 3% - 11% higher grain yield from 2006-2010. Comparing with CPTR, non puddled MTR produced 3%, 5%, 8%, 6%, and 11% higher grain yield in 2006, 2007, 2008, 2009, and 2010. The Crop established with mechanical transplanting method resulted in higher average grain yield of 6.66 t ha^{-1} than manual transplanting method resulted average grain yield of 5.83 t ha^{-1}. The net return of manual and mechanical transplanting method was ₹ 42310 and ₹ 61080 t ha^{-1}. The benefit cost ratios (BCR) were 2.24 and 1.78 for mechanical transplanting method and manual transplanting method, respectively Munnaf *et al.,* (2014).

Graded levels of nitrogen on growth, yield, quality and economics of rice

Nitrogen is an essential plant nutrient being a component of amino acids, nucleic acids, nucleotides, chlorophyll, enzymes, and hormones. N promotes rapid plant growth and improves grain yield and grain quality through higher tillering, leaf area development, grain formation, grain filling, and protein synthesis. Nitrogen is so vital because it is a major component of chlorophyll, the compound by which plants use sunlight energy to produce sugars from water and carbon dioxide (i.e., photosynthesis). It is also a major component of amino acids, the building blocks of proteins. Among the nutrients, nitrogen is required in comparatively greater quantities than other essential elements derived from the soil. Nitrogen plays a vital role in the growth and consequently the yield of crops. Deficiency of soil nitrogen supply is one of the main limiting factors for achieving high rice yields. Hence, constant replenishment through extraneous nitrogen inputs becomes mandatory for optimal yield Qiao-gang *et al.,* (2013).

An increase in nitrogen supply increased number of grains per panicle and 1000 grain weight, grain yield and number of tillers per hill Manzoor *et al.,* (2006), nutritive quality of straw Nori *et al.,* (2008) and number of panicle bearing tillers and harvest index. However, within soil the applied nitrogen undergoes several complex physical and chemical transformations which either decrease or increase the availability of nitrogen fertilizer to plant roots. The maximum yield of 4.72 t ha^{-1} was obtained at 125 kg N ha^{-1} (N_3) followed by N_2 (100 kg N ha^{-1}) giving yield of 4.58 t ha^{-1}. The minimum yield of 4.29 t ha^{-1} was obtained at the minimum nitrogen level 75 kg N ha^{-1} Ehsanullah *et al.,* (2001). The experiment with 4 levels of N (0, 40, 80 and 160 kg N ha^{-1}) applied at three levels to each of the planting density (20, 40 and 80 hills m^{-2}) it was observed that tillers $plant^{-1}$ increased linearly with the increase in N fertilizer levels Mannujan *et al.,* (2001). Rice cultivars Mahi Sugandha, Pusa Basmati 1 and Pusa Basmati 370 with N rates of 0, 40, 80 or 120 kg N ha^{-1} in Rajasthan, India during the rainy season of 1997 to determine the effects of N on the yield of the crops. They found that Basmati 1 give highest number of panicles m^{-2} (336) than others. Yield attributes of the crop increased with increasing rates of N Sharma and Dadhich (2003).

Application of 120 kg Nha^{-1} recorded significantly higher N, P and K uptake in rice compared to the rest of the N levels. Every increment of 40 kg N ha^{-1} from 0 to 120 kg N ha^{-1} increased the total N uptake by 49.55, 34.30 and 27.17%, total P uptake by 40.33, 27.06 and 20.32% and total K uptake by 32.43, 20.70 and 17.25%, respectively Mhaskar and Thorat (2005). Maximum paddy yield (4.24 t ha^{-1}) was obtained from 175 kg ha^{-1} nitrogen application treatment which also produced highest values of number of grains $panicle^{-1}$ (130.2) along with a maximum 1000 grain weight (22.92 gm) Manzoor *et al.*, (2006). Application of nitrogen up to 120 kg N ha^{-1} significantly increased the leaf area index at flowering stage. Significant increase in dry matter accumulation was recorded with application of N up to 90 kg ha^{-1} Naseer and Bali (2007). Starter dose 125 kg N ha^{-1} recorded significantly higher plant height, more number of tillers $hill^{-1}$ and dry matter accumulation over its lower levels Shekara and Nagarajushreedhara (2010). Increasing levels of nitrogen progressively enhanced number of panicles m^{-2}, number of filled grains $panicle^{-1}$, grain and straw yield of rice only up to 120 kg N ha^{-1} Murthy *et al.*, (2012). Similarly Sharma *et al.,* (2012) observed that treatment N_{120} P_{45} kg ha^{-1} produced maximum panicles m^{-2} which was statistically at par with N_{90} P_{45} and N_{90} P_{30} kg $ha^{-1.}$ The maximum number of tillers m^{-2} was observed with the application of $N_{120}P_{45}$ kg $ha^{-1}$and maximum increase was observed at 60-90 days after transplanting. Pramanik and Bera (2013) confirmed that, among the nitrogen levels N_{200} kg ha^{-1} gave significant higher plant height, panicle initiation, number of tillers $hill^{-1}$, total chlorophyll content, panicle length and straw yield and nitrogen levels; N_{150} kg ha^{-1} gave significant higher number of effective $tillers^{-1}$, effective tiller index, panicle weight, filled grain $panicle^{-1}$, 1000 grain weight, grain yield, and harvest index as compared to N_0, N_{50}, N_{100} during both years (2010 and 2011). The highest number of tiller was obtained at the fertilizer level of 90 kg ha^{-1} nitrogen with 526.7 tillers m^{-2}. The maximum biologic yield was on treatment N_4 (90 kg ha^{-1}) with 9587 kg ha^{-1} while the minimum one was related to N_1 (0 kg ha^{-1}) with 5348 kg ha^{-1} Moridani *et al.*, (2014). Nitrogen had significant positive effect and was equally superior in terms of tillers $hill^{-1}$, grains $panicle^{-1}$and straw yield. Highest number of panicle m^{-2} was recorded with 160 kg N ha^{-1}, however differences in filled grain $panicle^{-1}$ between 120 kg N ha^{-1} and 160 kg Nha^{-1} was statistically similar. Differences in grain yield between 160 kg N ha^{-1} (44.68 q ha^{-1}) and 120 kg N ha^{-1} (43.53 q ha^{-1}) were statistically at par Sharma *et al.*, (2014). Basmati rice yield significantly increased from 1.7 t ha^{-1}(control) to a maximum of 9.4 t ha^{-1} (90 kg N ha^{-1}) before declining to 5.8 t ha^{-1} (150 kg N ha^{-1}) in the order: 0 < 30 < 60 < 150 < 120 < 90 kg N ha^{-1} respectively Moro *et al.,* (2015). Similar findings are also confirmed Wani *et al.,* (2016).

From the present study conducted on influence of different planting system and graded levels of nitrogen on growth, yield, quality and economics of rice (*Oryza Sativa*

L.) it may be concluded that by practicing System of Rice Intensification and followed by 120 kg Nitrogen ha^{-1} has significantly perform better than all others planting system and levels of nitrogen for obtaining highest seed yield, stover yield, benefit cost ratio and protein content in rice. The findings are similar with various reviews which are presented in this article. This study will be helpful to researcher and farmers in increase the rice production per unit area by using different planting methods and levels of nitrogen dose. Similarly it also help to meet the daily food requirement and to supply adequate amount of Carbohydrates, protein, vitamin and minerals requirement in terms of nutritional security to farming community.

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