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Effect of different nitrogen levels on crop growth of various rice cultivars

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Abstract
An experiment were done to analyze the effect of different nitrogen levels on crop growth of various rice cultivars with different rice varieties. Six cultivars from rice (Naveen, Indira, Ratna, Surendra, Birupa and Daya) were evaluated in the kharif season 2017-2018. The experiment were conducted in factorial randomized block design with three replications. Among the cultivars of rice, the effect of nitrogen levels on crop growth rate found to be proportional till the vegetative stage and then diminishing effect on crop growth rate is observed during reproductive stage. The highest CGR was observed in naveen and birupa and lowest in daya and surendra.

Keywords: Crop growth rate (CGR), nitrogen (N), maximum tillering (MT), panicle initiation (PI), flowering (FL), grain filling (GF) and maturity

Introduction

Nitrogen (N) is the most important essential element for the overall growth and development of plants. Despite its high abundance in the air (around 79%), it is not readily available for them; rather, it is added mostly as inorganic fertilizer in the agricultural lands. Globally, 50% of human population relies on nitrogen (N) fertilizer for food production (Smil 2001) [12]. The N fertilizer consumption has grown dramatically in Asia, about 17-fold in the last 40 years (Ali *et al.* 1999; Dobermann and Cassman 2004; Rahn *et al.* 2009) [2]. However, it is remarkable that only 50% or less of the applied nitrogen is used for the production of the aboveground biomass of cereals. Optimum nutrient management has long been acknowledged as being critical for producing high yield in rice. Unless the supply of fertilizer nutrients to the crop is increased, low availability will remain as a serious constraint to increase rice production.

Temperature, solar irradiance, and water are the important biophysical factors controlling crop growth and crop demand for N and hence NUE. Farmers cannot control temperature and solar irradiance. Water also remains outside their control, unless the infrastructure for irrigation is in place. The predictability of these three plant growth factors largely depends on the climatic region where the crop is grown. Following solar irradiance, temperature, and water, inadequate availability of nutrients, particularly N, is the next plant growth limiting factor. High yielding crops require large amounts of nutrients, which have to be supplied as inorganic or organic amendments. Irrigation and fertilization are thus the most effective means of increasing crop yields at many sites (Norwood, 2000) [8].

Agronomic practices such as applying N at the right time, in the right amount, and at the right place will improve crop health and reduce pest incidence. Crop cultivars also differ in their ability to acquire N from the soil in producing yield per unit of N acquired. Nitrogen accumulation or uptake in different plant parts, as well as in the whole plant, during different phases of growth, clearly indicate higher nitrogen accumulation in stems and leaves during vegetative phase. Hence, nitrogen accumulation in different organs and in the whole plant follows a parabolic pattern during the ontogenic development of the plant (Basuchaudhuri, 2016).

It is evident that nitrogen concentrations in different plant parts decrease with ageing. However, a sharp decline in nutrient concentrations in leaves and stem was noted during ripening. Reduction in concentration of nutrients in plant parts, with time may possibly be attributed to slow rate of uptake along with dilution effect caused by gradient movement of nitrogen to the developing grains (Ishizuka, 1965) which can possibly analyzed with crop growth rate.

Distribution of any nutrients in plant system depends on its mobility in the plant. The nitrogen being a mobile nutrient in plant is always distributed mostly to new growing organs regardless of growth stages of the plant, while a much smaller amount of nitrogen is also distributed to older parts of the plant. Distribution and redistribution of the nitrogen absorbed at the young panicle formation stage were followed in a rice plant during panicle development. It was suggested that some of the nitrogen is directly transported to panicles from roots (Mae, 1986) [5]. Nitrogen required during panicle formation stage contributes to spikelet production. Similarly, N during pre heading stage contributes to carbohydrate accumulation in culms and leaf sheath. And lastly plants require N at grain filling stage for carbohydrate content in grain (Mae, 1997) [6]. Imsande and Touraine (1994) [4] and Marschner *et al.*, (1997) [7] reported that the uptake process and N homeostasis are complex processes that involve recycling of N (especially amino acids) from shoots to roots via the phloem, and from roots to shoots via the xylem during the whole life cycle of the crop therefore, growth analysis can be used to account for growth in terms that have functional or structural significance. The type of growth analysis requires measurement of plant biomass and assimilatory area (leaf area) and methods of computing certain parameters that describe growth

Material and methods

The experiment is conducted at research farm of ICAR-National Rice Research Institute, Cuttack, Odisha, India (20°25/N, 85°55/E; elevation 24 m above mean sea level) having sub-humid tropical climate during Kharif season. Experimental plot is especially designed to carry out nitrogen experiments. Cemented bunds are having plot size – 6m*4m ($24m^2$) which is one meter deep from the surface to avoid seepage across the bunds and half meter high from the surface to allow submergence condition to the crop.

Six rice cultivars with varying N response viz- Naveen, Indira, Ratna, Surendra, Birupa and Daya were grown under different six levels of nitrogen (N1: 0; N2: 40; N3: 60; N4: 80; N5: 100; N6:150 kg N $ha^{-1)}$. The treatments were led in factorial randomized block design with three replications of treatments. Before two to three day of transplanting plots were flooded followed by puddling, 25 days seedling were transplanted with plant to plant distance 15 cm and row to row spacing 20 cm. Nitrogen was applied in three splits one third on basal and remaining two third in equal splits at maximum tillering and panicles initiation stage. Phosphorous and potass ium were applied once (40 kg ha^{-1}) at the time of transplanting through single super phosphate and murate of potash respectively. Flood irrigation was applied to keep 3-5 cm standing water during the cropping season. Standard crop management practices were followed to control weed, pest and diseases. Data related to soil and plant parameters were collected were collected at important growth stages i.e., Maximum tillering, Panicle initiation, Flowering, Grain filling and maturity.

Five hills were uprooted randomly from adjacent to net plot rows excluding border rows at MT, PI, FL, GF and at harvest. The root portion of the plant was discarded. The above ground portion of the plant samples were washed under tap water and dried in hot air oven at 70˚C till a constant weight was obtained. The oven dry weight of samples was expressed as dry matter accumulation in t ha^{-1}. The plant samples at MT, PI, FL, GF and at harvest were partitioned into leaves, shoots and grains and were weighed separately.

Crop growth rate (CGR) (g m^{-2} d^{-1})

CGR= (W2-W1)/ (T2-T1)

Where, W1: Total biomass of crop at time T1; W2: Total biomass of crop at time T2; T1: Time in days after transplanting as first sampling; T2: Time in days after transplanting as second sampling.

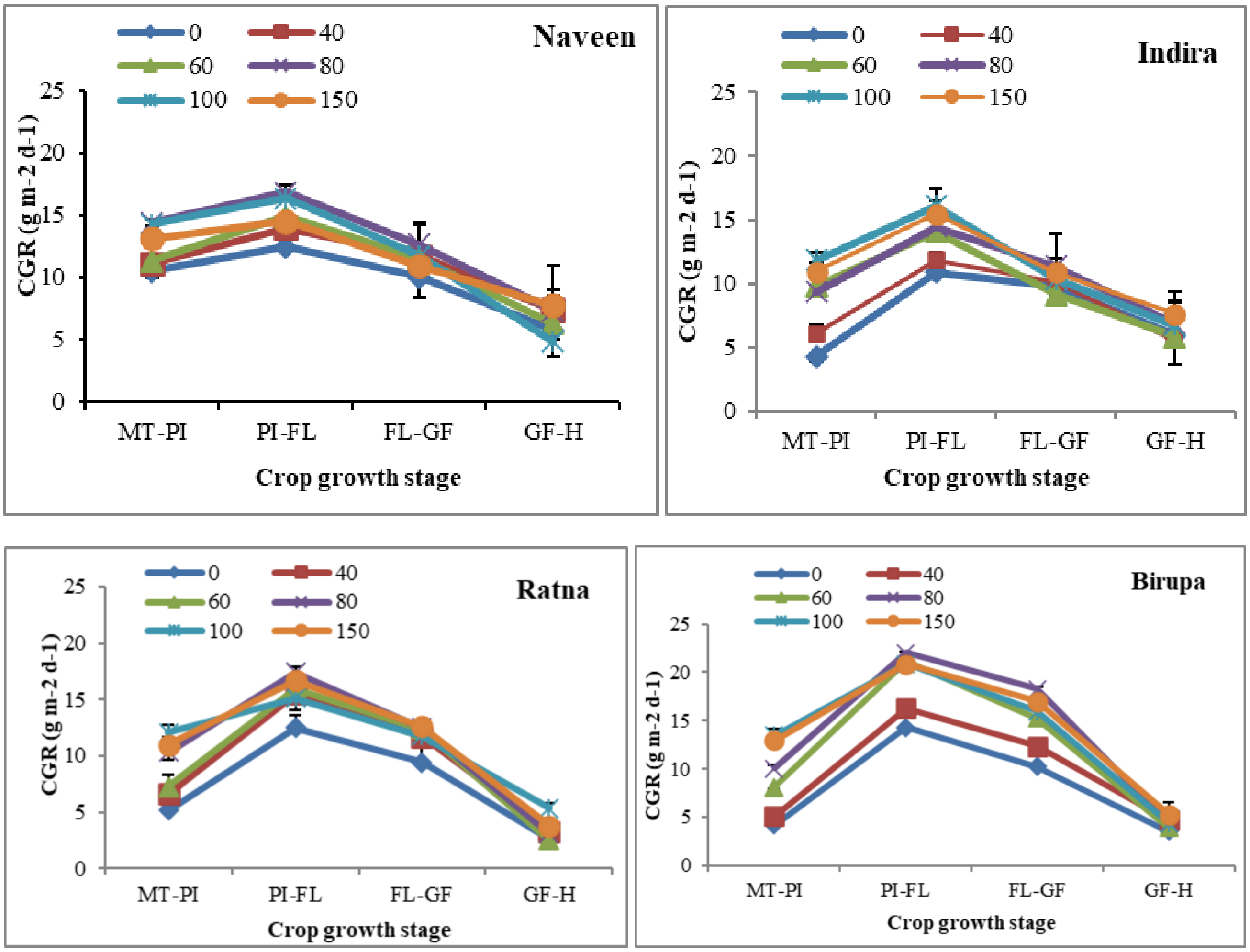
Result and discussion

Crop growth rate showed an increasing trend up to FL stage after that it decreases. The maximum growth rate was observed during PI to FL stage. Between MT to PI stage, the average CGR across cultivars ranged from 8.13 to 12.83 g m^{-2} d^{-1} and the highest was recorded in naveen and the lowest in daya. Between PI to FL stage, the average CGR across cultivars ranged from 14.39 to 20.25 g m^{-2} $d^{-}$and the highest was recorded in Birupa and the lowest in daya Between FL to GF stage, the average CGR across cultivars ranged from 8.46 to 15.78 g m^{-2} $d^{-}$and the highest was recorded in birupa and the lowest in surendra. Between GF to maturity stage, the average CGR across cultivars ranged from 2.82 to 6.70 g m^{-2} $d^{-}$and the highest was recorded in naveen and the lowest in surendra. Slow crop growth rate at earlier stages of the rice variety might be due to lower leaf development which act as a main organ of photosynthesis on which growth rate depends (Islam *et al*., 2007). The declining trend of crop growth rate during later stage towards maturity could be due excessive leaf senescence after reproductive stage followed by diminishing photosynthesis rate (Azarpour *et al*., 2014; Sinclair, T.R. and Sheehy, J.E., 1999) [1, 11], increasing respiration burden (Penning-de-Vries *et al*., 1989) [9] and reduced N uptake during post anthesis period (Schnier *et al*., 1990; Fu *et al*., 2009) [10, 3]

Table 1: CGR (g m^{-2} day^{-1}) from maximum tillering to grain filling stage of different varieties

S. No.	Treatment	N doses (kg ha-1)						
	Varieties(V)	0	40	60	80	100	150	mean
A	CGR (g m^{-2} day^{-1}) from maximum tillering to panicle initiation stage of different varieties							
	Naveen	10.51	11.08	11.34	14.40	14.25	13.10	12.83
	Indira	4.30	6.05	9.79	9.33	11.83	10.96	9.59
	Ratna	5.14	6.60	7.25	10.33	12.07	11.00	9.45
	Surendra	6.54	9.07	9.47	10.86	11.93	12.44	10.75
	Birupa	4.24	5.09	8.12	10.06	13.50	12.93	9.94
	Daya	4.59	5.87	7.60	8.51	9.91	8.76	8.13
	Mean	5.79	7.02	8.50	10.24	11.93	11.53	9.85
B	CGR (g m^{-2} day^{-1}) from panicle initiation to flowering stage of different varieties							
	Naveen	12.42	13.98	14.87	16.84	16.33	14.50	15.30

	Indira	10.87	11.81	14.06	14.45	16.13	15.47	14.39
	Ratna	12.46	15.47	15.99	17.41	15.14	16.71	16.14
	Surendra	15.23	14.02	16.49	15.57	17.62	17.58	16.26
	Birupa	14.28	16.29	21.19	22.01	20.87	20.88	20.25
	Daya	12.33	14.27	17.14	18.04	16.83	18.79	17.01
	Mean	13.72	15.30	17.31	18.16	17.73	17.95	17.29
C	**CGR (g m^{-2} day^{-1}) from flowering to grain filling stage of different varieties**							
	Naveen	9.98	11.70	11.48	12.64	11.72	10.89	11.69
	Indira	9.77	10.09	9.15	11.36	10.33	10.91	10.37
	Ratna	9.43	11.70	12.34	12.46	11.78	12.63	12.18
	Surendra	4.50	5.31	7.49	7.88	11.19	10.41	8.46
	Birupa	10.26	12.38	15.28	18.30	15.96	16.98	15.78
	Daya	9.06	11.01	12.19	12.39	11.96	10.30	11.57
	Mean	8.87	10.44	12.05	13.20	12.35	12.44	12.09
D	**CGR (g m^{-2} day^{-1}) from grain filling to maturity stage of different varieties**							
	Naveen	5.74	7.35	6.27	7.31	4.84	7.74	6.70
	Indira	5.93	5.57	5.84	6.82	6.73	7.64	6.52
	Ratna	2.63	3.28	2.51	3.11	5.34	3.77	3.60
	Surendra	3.03	2.16	2.65	3.31	1.98	3.98	2.82
	Birupa	3.54	4.72	3.96	4.38	4.42	5.29	4.55
	Daya	6.93	5.65	4.98	7.30	7.19	7.20	6.46
	Mean	4.49	4.68	4.38	5.12	5.02	5.43	4.93



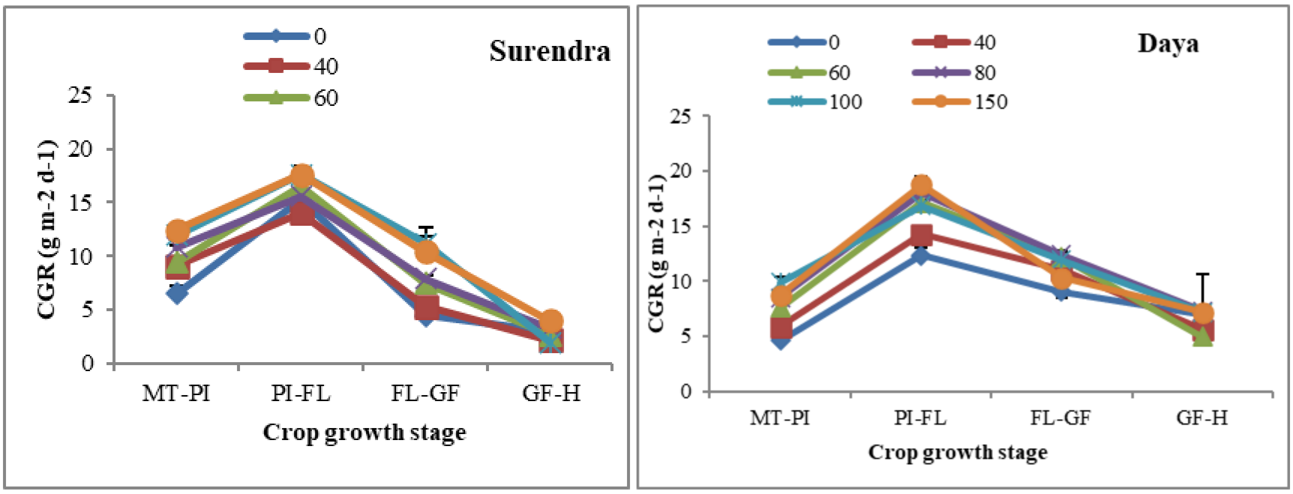


Fig 4.3: Crop growth rate among all the seven varieties in different N doses at crop growth stages

Conclusion

Different cultivars vary in N use efficiency. Some of the cultivars show crop growth under lower N levels, as Naveen and Birupa can be called as efficient varieties. Whereas some varieties show high yield under high N levels, as Surendra and Daya observed to be having low crop growth rate under diiffernt levels of nitrogen. The diminishing trend of crop growth rate during later stage towards maturity could be due excessive leaf senescence after reproductive stage followed by reduced photosynthesis rate due to end of vegetative phase, needs, reduced N uptake during post anthesis period and increasing respiration burden for reproduction.

References

1. Azarpour E, Moraditochaee M, Bozorgi HR. Effect of Nitrogen Fertilizer Management on Growth Analysis of Rice Cultivars. International Journal of Biosciences. 2014; 4:35-47.
2. Dobermann A, Cassman KG. Environmental dimensions of fertilizer nitrogen, 2004.
3. Fu JD, Yan YF, Lee BW. Physiological Characteristics of a Functional Stay-Green Rice SNU-SG1 during Grain-filling Period. Journal of Crop Science and Biotechnology. 2009; 12:47-52.
4. Imsande J, Touraine B. N demand and the regulation of nitrate uptake. Plant Physiology. 1994; 105:3-7.
5. Mae T, Ohira K. The remobilization of nitrogen related to leaf growth and senescence in rice plants (*Oryza sativa* L.). Plant and Cell Physiology. 1986; 22:1067-1074.
6. Mae T. Physiological nitrogen efficiency in rice: nitrogen utilization, photosynthesis, and yield potential. Plant and Soil. 1997; 196:201-210.
7. Marschner H, Kirby EA, Engels C. Importance of cycling and recycling of mineral nutrients within plants for growth and development. Botanica Acta. 1997; 110:265-273.
8. Norwood CA. Water use and yield of limited-irrigated and dryland corn. Soil Sci. Soc. Am. J. 2000; 64:365-370.
9. Penning-de-Vries FWT, Jansen DM, Ten-Berge HFM, Bakema A. Simulation of Ecophysiological Processes of Growth in Several Annual Crops. Pudoc, Wageningen. Scope 65, Paris, France. 1989; 291:261-278.
10. Schnier HF, Dingkuhn M, De-Datta SK, Mengel-Wijangco E, Javellana C. Nitrogen Economy and Canopy CO_2 Assimilation in Tropical Lowland Rice. Agronomy Journal. 1990; 82:451-459.
11. Sinclair TR, Sheehy JE. Erect Leaves and Photosynthesis in Rice. Science. 1999; 283:1456-1457.
12. Smil V. Nitrogen and food production: Proteins for human diets. Ambio. 2001; 31:126-131.