Effect of Different Nitrogen Levels on Biochemical Parameters of Rice Genotypes (*Oryza sativa* L.)

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Abstract

Field experiment was conducted during 2016-17 and 2017-18 to study the response of rice genotypes on Growth and morpho-physiological parameters under three nitrogen levels 120 kg N ha⁻¹, 80 kg N ha⁻¹ and 40 kg N ha⁻¹ as main treatments and twenty rice genotypes as sub treatments, which was carried out at experimental site of Department of Plant Physiology, IGKV, Raipur (C.G.) with Split plot design along with two replications. In the present investigation among the nitrogen treatments, application of 120 kg N ha⁻¹ recorded significantly higher values for growth and morpho-physiological parameters such as plant height, number of tillers/plant, number of effective tillers/plant, number of panicle/m², panicle length, flag leaf area, specific leaf area and specific leaf weight. Among the genotypes, DXD (124)-17-193 followed by DXD (124)-17-192 and DXD (124)-3-28 recorded the maximum grain yield even under all the treatments, which also gives better result on the other growth and morpho-physiological parameters. This indicated that maximum yield can be attributed to maximum number of panicles, more photosynthetic rate, more tillers and effective tillers, more flag leaf area, maximum specific leaf weight and minimum specific leaf area.

Keywords: Rice; Growth parameters; Morphological parameters; Nitrogen; FLA; SLW; SLA

Introduction

Rice (*Oryza sativa* L.) is the staple food of more than half of the world population belonging to the family Poaceae. The cultivated rice (*Oryza sativa*) is divided into three subspecies-indica, javanica and japonica. In Asia, two main subspecies-indica and japonica are grown. Indica rice comprises 80% of cultivated rice in the world. Rice is the most important and extensively cultivated food crop that has been referred as 'Global grain' because of its use as prime staple food in about 100 countries of the world. The main rice growing in Kharif (monsoon) season (June to December) in the eastern region of India comprising the state of West Bengal, Assam, Bihar, MP, CG.

The crop productions mostly depend upon the nutrients. After water stress, nutrients are recognized as the second most limiting factor in Asia [1]. As we applied the nutrients the crop performance increased and vice versa. Balanced fertilization right from the very beginning of crop growth is most essential to achieve better harvest of crop. Nitrogen is a very essential nutrient for plant growth and development. Nitrogen management play an important role in rice production. Need based Nitrogen application to rice crop enhance grain production; hence it is the most yield limiting nutrient in rice cropping systems worldwide. India stands third and second in N fertilizer consumption and production respectively [2].

The most pressing target of improving agricultural NUE is to improve the recovery of Nitrogen from fertilizer. Nitrogen use efficiency had synergistic effect as RUE increased at higher leaf nitrogen contents. In recent year new approaches for high Nitrogen use efficiency are assuming importance. Achieving higher yield with reduced nitrogen fertilization, without considerable effects on the

normal physiological processes of functional leaves, has become an important challenge in rice.

Rice cultivars adapted to various geographical conditions differ in their nitrogen requirements. Cultivars that are properly grown and work on low nitrogen dose have a great challenge for us. Thus, identification of such rice cultivar will be essential in developing high yielding varieties that can survive in low nitrogen condition. Subsequently, enable double cropping per year is undoubtedly a promising approach for the global improvement of food grain production. Therefore, this present study was carried out in order to examine the nitrogen use efficiencies on the growth and yield of local rice as a prelude to breeding for short rotation variety under irrigated environment, particularly for Chhattisgarh. With this available background information, the present study on "Evaluation of different promising rice (*Oryza sativa* L.) genotypes for nitrogen use efficiency and their sink potential" are conducted with the following objectives.

To evaluate the impact of different nitrogen levels on physiological and growth parameters of rice (*Oryza sativa* L.).

Materials and Methods

The experiment field was laid out in complete split plot design with two replications. Each replication consisted of three main plot (Nitrogen treatments T1-120 kg N, T2-80 kg N and T3-40 kg N) and twenty sub plot (rice genotypes) conducted at the Department of Plant Physiology, Agricultural Biochemistry and MAPs. College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur during 2016-17 and 2017-18. The growth parameters included plant height, number of tillers/plant, number of effective tillers/plant, number of panicle/m², panicle length, flag leaf area, specific leaf area and specific leaf weight of all three tagged plants of each treatment and replications was measured at 50% flowering stage.

Plant height was measured from the base of the plant to the tip of the longest leaf. It was measured with standard meter stick at flowering stage. Plant height was recorded in conjunction with the periodic biomass sampling. The plant height was expressed in cm. The number of tiller were counted during the dry matter sampling of hills (three) at flowering stage and was expressed in tillers plant⁻¹. They were pooled and average number of tillers plant⁻¹ was presented. The upper most fully expanded leaf of the mother tiller was selected for the estimation of flag leaf area at flowering stage. The maximum length and maximum width of flag leaf were recorded at flowering stage and a factor of 0.75

was used to calculate the flag leaf area. It was expressed as cm². Flag leaf area=Length × Width × k (Factor 0.75)

To estimate specific leaf area, the leaf area was measured and divided by leaf weight and calculated with the following formula: Specific leaf area (SLA)=(Leaf area plant⁻¹)/(Leaf dry weight plant⁻¹).

To estimate specific leaf weight, the leaf area and leaf weight was measured and calculated with the following formula: Specific leaf weight (SLW)=(Leaf dry weight plant⁻¹)/(Leaf area plant⁻¹) (Table 1).

S.No.	Entry no.	S.No.	Entry no.	S.No.	Entry no.
1	DXD (124)-1-12	8	DXD (124)-3-59	15	DXD (124)-11-133
2	DXD (124)-1-14	9	DXD (124)-3-60	16	DXD (124)-15-164
3	DXD (124)-2-17	10	DXD (124)-4-70	17	DXD (124)-17-192
4	DXD (124)-2-20	11	DXD (124)-5-72	18	DXD (124)-17-193
5	DXD (124)-2-22	12	DXD (124)-6-74	19	DXD (124)-17-210
6	DXD (124)-3-28	13	DXD (124)-9-89	20	DXD (124)-17-211
7	DXD (124)-3-30	14	DXD (124)-9-91		

Table 1: Treatments details of the experiment.

Results and Discussion

Plant height (cm) under nitrogen treatment

The data on plant height presented in Table 2. Significant differences were noted among different nitrogen treatments in relation to plant height during both the years (2016-17 and 2017-18) as well as in pooled data.

In case of 120 kg N, the minimum plant height was recorded in rice DXD (124)-4-70 (106.4 cm) followed by DXD (124)-3-59 (113.1 cm) and DXD (124)-17-210 (115.1 cm). Maximum plant height was observed under DXD (124)-3-60 (185.1 cm) followed by DXD (124)-1-12 (169.9) and DXD (124)-1-14 (165.8 cm).

In 80 kg N, the minimum plant height was recorded in rice genotype DXD (124)-9-91 (96.1 cm) followed by DXD (124)-4-70 (103.6 cm) and DXD (124)-1-14 (165.5 cm) was found maximum plant height followed by DXD (124)-3-60 (166.7 cm) and DXD (124)-1-12 (165.9). Under 40 kg N, the minimum plant height was recorded in rice genotype DXD (124)-9-91 (92.4 cm) followed by DXD (124)-4-70 (104.2 cm), DXD (124)-2-22 (104.7 cm) and DXD (124)-1-14 (157.1 cm) was found maximum plant height followed by DXD (124)-1-12 (151.7 cm) and DXD (124)-3-60 (149.3). In this investigation found that higher plant height was observed under higher dose of nitrogen as compared to other treatment.

S.No.	Name of rice genotypes	Number of tillers/plant									Number of effective tillers/plant								
		2016			2017			Pooled			2016			2017			Pooled		
		T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
1	DXD (124)-1-12	14.2	12.5	7.5	16.2	13.7	8.3	15.2	13.1	7.9	12.5	8.8	5.0	13.5	10.0	6.3	13.0	9.4	5.6
2	DXD (124)-1-14	11.3	9.8	6.2	13.3	11.0	7.1	12.3	10.4	6.6	10.0	8.3	5.3	11.0	9.5	6.5	10.5	8.9	5.9
3	DXD (124)-2-17	11.7	9.8	7.3	13.7	11.0	8.8	12.7	10.4	8.1	9.5	7.5	4.5	10.5	8.7	5.8	10.0	8.1	5.1
4	DXD (124)-2-20	11.9	10.0	7.5	13.9	11.2	8.8	12.9	10.6	8.1	10.0	8.3	5.5	11.0	9.5	6.8	10.5	8.9	6.1
5	DXD (124)-2-22	12.9	11.0	6.0	14.9	12.2	7.0	13.9	11.6	6.5	11.3	8.0	4.5	12.3	9.2	5.8	11.8	8.6	5.1
6	DXD (124)-3-28	13.8	11.8	6.2	15.8	13.0	7.4	14.8	12.4	6.8	11.8	8.3	4.5	12.8	9.5	5.8	12.3	8.9	5.1
7	DXD (124)-3-30	10.7	7.8	4.3	12.7	9.0	4.7	11.7	8.4	4.5	7.8	5.0	3.5	8.8	6.2	4.8	8.3	5.6	4.1
8	DXD (124)-3-59	10.3	8.8	7.3	12.3	10.0	8.2	11.3	9.4	7.8	8.7	6.3	4.5	9.7	7.5	5.8	9.2	6.9	5.1

9	DXD (124)-3-60	9.3	7.1	6.0	11.3	8.3	7.0	10.3	7.7	6.5	7.7	5.8	5.0	8.7	7.0	6.3	8.2	6.4	5.6
10	DXD (124)-4-70	12.4	10.3	7.1	14.4	11.5	8.3	13.4	10.9	7.7	8.8	6.3	5.8	9.8	7.5	7.0	9.3	6.9	6.4
11	DXD (124)-5-72	12.7	10.2	7.7	14.7	11.4	8.3	13.7	10.8	8.0	9.7	6.8	5.8	10.7	8.0	7.0	10.2	7.4	6.4
12	DXD (124)-6-74	12.7	10.8	7.8	14.7	12.0	8.9	13.7	11.4	8.4	10.3	8.3	5.5	11.3	9.5	6.8	10.8	8.9	6.1
13	DXD (124)-9-89	13.3	11.4	8.7	15.3	12.6	10.0	14.3	12.0	9.3	11.5	10.0	7.0	12.5	11.2	8.3	12.0	10.6	7.6
14	DXD (124)-9-91	13.0	11.6	6.7	15.0	12.8	7.2	14.0	12.2	6.9	10.8	8.3	4.8	11.8	9.5	6.0	11.3	8.9	5.4
15	DXD (124)-11-133	12.1	10.3	5.5	14.1	11.5	5.8	13.1	10.9	5.6	10.5	7.5	4.8	11.5	8.7	6.0	11.0	8.1	5.4
16	DXD (124)-15-164	12.9	11.3	8.6	14.9	12.5	9.6	13.9	11.9	9.1	10.7	8.5	7.8	11.7	9.7	9.1	11.2	9.1	8.5
17	DXD (124)-17-192	12.4	10.0	7.5	14.4	11.2	8.3	13.4	10.6	7.9	10.5	7.8	5.5	11.5	9.0	6.8	11.0	8.4	6.1
18	DXD (124)-17-193	11.9	10.0	6.0	13.9	11.2	6.5	12.9	10.6	6.3	10.5	7.8	4.8	11.5	9.0	6.0	11.0	8.4	5.4
19	DXD (124)-17-210	13.9	12.0	9.0	15.9	13.2	10.0	14.9	12.6	9.5	12.3	9.4	7.0	13.3	10.6	8.3	12.8	10.0	7.6
20	DXD (124)-17-211	11.9	10.0	7.5	13.9	11.2	8.3	12.9	10.6	7.9	10.4	8.0	5.8	11.4	9.2	7.0	10.9	8.6	6.4
	Treatment mean	12.2	10.3	7.0	14.2	11.5	7.9	13.2	10.9	7.5	10.3	7.7	5.3	11.3	8.9	6.6	10.8	8.3	6.0
	Factors	CD	SE (d)	SE (m)	CD	SE (d)	SE (m)	CD	SE (d)	SE (m)	CD	SE (d)	SE (m)	CD	SE (d)	SE (m)	CD	SE (d)	
	Factor(N)	0.82	0.18	0.13	3.43	0.74	0.52	1.87	0.40	0.29	2.0	0.4	0.3	2.7	0.6	0.4	0.431	0.093	
	Factor(G)	0.72	0.36	0.25	0.46	0.23	0.16	0.16	0.08	0.06	0.9	0.5	0.3	0.9	0.5	0.3	0.005	0.002	
	GX N	1.37	0.62	0.56	1.61	0.40	0.34	1.06	0.14	0.07	2.1	0.8	0.4	2.4	0.8	0.6	0.019	0.004	
	NX G	1.40	0.63	0.45	3.39	0.83	0.59	1.86	0.43	0.30	2.4	0.9	0.6	2.9	1.0	0.7	0.431	0.093	

Table 2: Effect of Nitrogen levels on number of tillers/plant and number of effective tillers/plant of rice (*Oryza sativa* L.).

Number of tillers/plant under nitrogen treatment

The data on number of tillers/plant presented in Table 2. Significant differences were noted among different nitrogen treatments in relation to number of tillers/plant during both the years (2016-17 and 2017-18) and pooled data.

In case 120 kg N, the minimum Number of tillers/plant was recorded in rice DXD (124)-3-60 (10.3) followed by DXD (124)-3-59 (11.3), DXD (124)-3-30 (11.7) and DXD (124)-1-12 (15.2) was found maximum number of tillers/plant followed by DXD (124)-17-210 (14.9) and DXD (124)-3-28 (14.8).

In 80 kg N the minimum number of tillers/plant was recorded in rice genotype DXD (124)-3-60 (7.7) followed by DXD (124)-3-30 (8.4) and DXD (124)-1-12 (13.1) was found maximum number of tillers/plant followed by DXD (124)-17-210 (12.6) and DXD (124)-3-28 (12.4).

Under 40 kg N, the minimum number of tillers/plant was recorded in rice DXD (124)-3-30 (4.5) followed by DXD (124)-11-133 (5.6), DXD (124)-17-193 (6.3) and DXD (124)-17-210 (9.5) was found

maximum number of tillers/plant followed by DXD (124)-9-89 (9.3) and DXD (124)-15-164 (9.1).

Number of effective tillers/plant under nitrogen treatment

The data on number of effective tillers/plant presented in Table 3. Significant differences were noted among different nitrogen treatments in relation to number of effective tillers/plant during both the years (2016-17 and 2017-18) but pooled data showed significant difference.

In case 120 kg N, minimum number of effective tillers/plant was recorded in DXD (124)-3-60 (8.2) followed by DXD (124)-3-30 (8.3) and DXD (124)-1-12 (13), was found maximum number of effective tillers/plant followed by DXD (124)-17-210 (12.8) and DXD (124)-3-28 (12.3). In 80 kg N the minimum number of effective tillers/plant was recorded in rice genotype DXD (124)-3-30 (5.6) followed by DXD (124)-3-60 (6.4) and DXD (124)-9-89 (10.6) was found maximum number of effective tillers/plant followed by DXD (124)-17-210 (10).

Under 40 kg N, minimum number of effective tillers/plant was recorded in DXD (124)-3-30 (4.1) followed by DXD (124)-3-59, DXD (124)-2-17, DXD (124)-2-22 and DXD (124)-3- 28 (5.1) similarly.

Maximum number of effective tillers was observed under DXD (124)-17-210 (7.6) similarly. Number of maximum effective tillers (124)-15-164 (8.5) followed by DXD (124)-9-89 and DXD observed in the 120 kg N as compared to other nitrogen treatment.

S.No.	Name of rice genotypes	Number of panicle m ⁻²								
		2016			2017			Pooled		
		T1	T2	T3	T1	T2	T3	T1	T2	T3
1	DXD (124)-1-12	412.7	365.1	165.0	428.6	409.6	142.5	420.7	387.3	153.8
2	DXD (124)-1-14	342.6	297.0	173.3	396.1	339.5	175.0	369.4	318.3	174.1
3	DXD (124)-2-17	313.7	266.1	148.5	380.1	310.6	145.0	346.9	288.3	146.8
4	DXD (124)-2-20	342.6	297.0	181.5	397.1	339.5	175.0	369.9	318.3	178.3
5	DXD (124)-2-22	378.4	331.4	148.5	414.1	375.3	150.0	396.2	353.3	149.3
6	DXD (124)-3-28	407.2	362.3	148.5	431.1	404.1	152.5	419.2	383.2	150.5
7	DXD (124)-3-30	300.0	244.2	111.0	382.1	286.9	125.0	341.0	265.5	118.0
8	DXD (124)-3-59	298.6	253.0	148.5	377.1	295.5	142.5	337.9	274.3	145.5
9	DXD (124)-3-60	282.1	231.8	165.0	372.1	274.0	150.0	327.1	252.9	157.5
10	DXD (124)-4-70	333.0	277.2	189.8	400.1	319.9	175.0	366.5	298.5	182.4
11	DXD (124)-5-72	364.6	324.5	189.8	417.1	361.5	170.0	390.9	343.0	179.9
12	DXD (124)-6-74	345.4	298.4	181.5	401.1	342.3	167.5	373.2	320.3	174.5
13	DXD (124)-9-89	371.5	328.7	212.0	412.6	370.9	185.0	392.0	349.8	198.5
14	DXD (124)-9-91	349.5	297.6	156.8	402.1	340.6	150.0	375.8	319.1	153.4
15	DXD (124)-11-133	346.7	297.8	156.8	402.6	341.1	145.0	374.7	319.5	150.9
16	DXD (124)-15-164	339.9	296.5	208.5	397.6	339.5	190.0	368.7	318.0	199.3
17	DXD (124)-17-192	371.5	327.9	181.5	420.1	368.4	170.0	395.8	348.2	175.8
18	DXD (124)-17-193	346.7	299.1	156.8	404.1	343.6	147.5	375.4	321.3	152.1
19	DXD (124)-17-210	410.7	364.0	231.0	437.6	407.6	190.0	424.1	385.8	210.5
20	DXD (124)-17-211	351.4	304.9	169.8	408.6	348.3	170.0	380.0	326.6	169.9
	Treatment mean	350.0	303.2	171.2	404.1	345.9	160.9	377.3	324.6	166.0
	Factors	CD	SE	SE (m)	CD	SE (d)	SE (m)	CD	SE (d)	SE (m)
	Factor(N)	2.8	0.6	0.4	125.0	27.0	19.1	112.1	24.2	17.1
	Factor(G)	9.7	4.8	3.4	17.3	8.6	6.1	10.6	5.3	3.7
	GX N	16.9	8.4	3.9	60.4	15.0	5.3	39.6	9.2	6.5
	NX G	16.5	8.2	5.8	123.9	30.7	21.7	111.4	25.8	18.2

Table 3: Effect of Nitrogen levels on number of panicle m⁻² of rice (*Oryza sativa* L.).

Number of panicle/m² under nitrogen treatment

The data on number of panicle presented in Table 4. Significant differences were noted among different nitrogen treatments in relation to number of number of panicle during both the years (2016-17 and 2017-18) and pooled data also.

In case of 120 kg N, minimum number of panicle was recorded in rice DXD (124)-3-60 (327.1) followed by DXD (124)-3-59 (337.9), DXD (124)-3-30 (341) and DXD (124)-17-210 (424.1) was found maximum number of panicle followed by DXD (124)-1-12 (420.7) and DXD (124)-3-28 (419.2).

In 80 kg N, the minimum number of panicle was recorded in rice genotype DXD (124)-3-60 (252.9) followed by DXD (124)-3-30 (265.5)

and DXD (124)-3-59 (274.3), whereas DXD (124)-1-12 (387.3) was found maximum number of panicle followed by DXD (124)-17-210 (385.8) and DXD (124)-3-28 (383.2). Under 40 kg N, minimum number of panicle was recorded in rice DXD (124)-3-30 (118) followed

by DXD (124)-3-59 (145.5), DXD (124)-2-17 (146.8) and DXD (124)-17-210 (210.5) was found maximum number of panicle followed by DXD (124)-15-164 (199.3) and DXD (124)-9-89 (198.5).

S.No.	Name of rice genotypes	Panicle length (cm)								
		2016			2017			Pooled		
		T1	T2	T3	T1	T2	T3	T1	T2	T3
1	DXD (124)-1-12	21.4	21.1	20.8	23.2	22.0	19.8	22.3	21.5	20.3
2	DXD (124)-1-14	20.7	20.4	20.6	22.5	22.1	19.6	21.6	21.3	20.1
3	DXD (124)-2-17	21.0	20.5	19.9	22.8	22.6	19.9	21.9	21.5	19.9
4	DXD (124)-2-20	20.4	19.8	20.2	22.2	22.7	19.2	21.3	21.3	19.7
5	DXD (124)-2-22	22.3	21.1	19.7	24.1	24.0	18.7	23.2	22.5	19.2
6	DXD (124)-3-28	21.1	20.7	19.5	22.9	24.2	18.5	22.0	22.4	19.0
7	DXD (124)-3-30	20.3	20.1	19.2	22.1	24.5	18.2	21.2	22.3	18.7
8	DXD (124)-3-59	20.4	20.0	17.7	22.2	24.9	16.7	21.3	22.4	17.2
9	DXD (124)-3-60	23.5	23.7	21.9	24.3	27.3	20.9	23.9	25.5	21.4
10	DXD (124)-4-70	21.3	21.2	20.7	23.1	26.6	23.7	22.2	23.9	22.2
11	DXD (124)-5-72	20.1	19.7	20.0	21.9	26.2	19.0	21.0	23.0	19.5
12	DXD (124)-6-74	23.1	22.5	22.9	24.9	28.1	21.9	24.0	25.3	22.4
13	DXD (124)-9-89	20.9	20.3	19.8	22.7	27.5	19.8	21.8	23.9	19.8
14	DXD (124)-9-91	27.5	27.1	25.3	29.3	31.5	26.3	28.4	29.3	25.8
15	DXD (124)-11-133	23.1	23.2	22.9	24.9	30.3	21.9	24.0	26.7	22.4
16	DXD (124)-15-164	19.8	19.5	19.7	21.6	28.6	18.7	20.7	24.0	19.2
17	DXD (124)-17-192	20.4	20.0	20.2	22.2	29.4	19.2	21.3	24.7	19.7
18	DXD (124)-17-193	18.9	18.7	18.7	20.7	29.3	17.7	19.8	24.0	18.2
19	DXD (124)-17-210	22.9	22.5	20.7	24.7	31.6	21.7	23.8	27.1	21.2
20	DXD (124)-17-211	20.6	20.1	19.3	22.4	30.9	18.3	21.5	25.5	18.8
Treatment mean		21.5	21.1	20.5	23.2	26.7	20.0	22.4	23.9	20.2
Factors		CD	SE	SE (m)	CD	SE (d)	SE (m)	CD	SE (d)	SE (m)
Factor(N)		0.27	0.06	0.04	4.08	3.83	2.71	3.90	2.18	1.55
Factor(G)		1.16	0.58	0.41	3.07	1.53	1.08	1.52	0.76	0.54
GX N		2.00	1.00	0.18	N/A	2.65	2.11	N/A	1.31	0.91
NX G		2.11	0.98	0.69	N/A	4.62	3.27	N/A	2.53	1.79

Table 4: Effect of Nitrogen levels on Panicle length of rice (*Oryza sativa* L.).

Panicle length (cm) under nitrogen treatment

The data on panicle length presented in Table 5. No significant differences were noted among different nitrogen treatments in relation to number of panicle length during the years and 2017-18 and pooled data but year 2016-17 gave significant differences.

In case of 120 kg N, minimum panicle length was recorded in rice DXD (124)-17-193 (19.8) followed by DXD (124)-15-164 (20.7), DXD (124)-5-72 (21) and DXD (124)-9-91 (28.4) was found maximum panicle length followed by DXD (124)-6-74 and DXD (124)-11-133 (24) similarly.

In 80 kg N, the minimum panicle length was recorded in rice genotype DXD (124)-1-14 (21.3) followed by DXD (124)-2-20 (21.3), whereas DXD (124)-9-91 (29.3) was found maximum panicle length followed by DXD (124)-17-210 (27.1). Under 40 kg N, the minimum

panicle length was recorded in rice genotype DXD (124)-3-9 (17.2) followed by DXD (124)-17-193 (18.2), whereas DXD (124)-9-91 (25.8) was found maximum panicle length followed by DXD (124)-6-74 and DXD (124)-11-133 (22.4) similarly.

S.No.	Name of rice genotypes	Flag leaf area (cm ²)								
		2016			2017			Pooled		
		T1	T2	T3	T1	T2	T3	T1	T2	T3
1	DXD (124)-1-12	80.9	65.9	60.9	52.5	50.6	42.5	66.7	58.2	51.7
2	DXD (124)-1-14	45.9	32.1	35.9	40.9	40.1	37.5	43.4	36.1	36.7
3	DXD (124)-2-17	57.2	36.8	27.2	52.2	38.4	32.5	54.7	37.6	29.9
4	DXD (124)-2-20	57.8	50.9	47.8	52.8	51.3	45.0	55.3	51.1	46.4
5	DXD (124)-2-22	46.1	38.3	36.1	41.1	45.0	36.0	43.6	41.7	36.0
6	DXD (124)-3-28	45.2	33.3	30.7	40.2	41.3	35.0	42.7	37.3	32.9
7	DXD (124)-3-30	49.7	26.4	32.2	44.7	40.0	38.0	47.2	33.2	35.1
8	DXD (124)-3-59	45.7	39.7	38.2	47.7	40.1	37.5	46.7	39.9	37.9
9	DXD (124)-3-60	45.7	39.8	38.2	60.7	47.5	40.5	53.2	43.6	39.4
10	DXD (124)-4-70	43.2	33.8	33.2	48.2	35.1	37.5	45.7	34.4	35.3
11	DXD (124)-5-72	44.3	39.8	39.3	49.3	37.1	40.5	46.8	38.5	39.9
12	DXD (124)-6-74	46.5	37.7	39.0	47.5	41.6	42.5	47.0	39.6	40.8
13	DXD (124)-9-89	34.8	31.2	27.3	40.8	35.4	32.5	37.8	33.3	29.9
14	DXD (124)-9-91	35.2	31.6	32.7	40.2	35.9	35.0	37.7	33.7	33.9
15	DXD (124)-11-133	45.9	45.1	41.9	56.9	53.3	37.5	51.4	49.2	39.7
16	DXD (124)-15-164	45.9	44.8	35.9	50.9	33.9	37.5	48.4	39.3	36.7
17	DXD (124)-17-192	41.9	35.5	31.9	46.9	39.5	38.0	44.4	37.5	35.0
18	DXD (124)-17-193	43.9	29.1	23.9	48.9	47.1	32.5	46.4	38.1	28.2
19	DXD (124)-17-210	35.7	27.9	28.2	46.7	40.6	31.0	41.2	34.2	29.6
20	DXD (124)-17-211	31.2	29.0	28.7	46.2	43.9	33.5	38.7	36.5	31.1
	Treatment mean	46.1	37.4	35.5	47.8	41.9	37.1	46.9	39.7	36.3
	Factors	CD	SE (d)	SE (m)	CD	SE (d)	SE (m)	CD	SE (d)	SE (m)
	Factor(N)	1.30	0.28	0.20	7.01	5.92	4.89	4.93	1.07	0.75
	Factor(G)	2.01	1.00	0.71	6.82	3.40	2.40	6.67	3.32	2.35
	GX N	3.60	1.73	0.89	8.20	5.89	4.90	7.02	5.76	3.37
	NX G	3.56	1.71	1.21	32.0	8.99	6.36	7.31	5.71	4.04

Table 5: Effect of Nitrogen levels on flag leaf area of rice (*Oryza sativa* L.).

Flag leaf area under nitrogen treatment

The data on flag leaf area presented in Table 6. Significant differences were noted among different nitrogen treatments in relation

to flag leaf area during both the years (2016-17 and 2017-18) as well as in pooled data.

In case of 120 kg N condition, the minimum flag leaf area was recorded in rice genotype DXD (124)-9-91 (37.7 cm²) followed by DXD (124)-9-89 (37.8 cm²), DXD (124)-17-211 (38.7 cm²) and DXD

(124)-1-12 (66.7 cm²) was found maximum flag leaf area followed by DXD (124)-2-20 (55.3 cm²), whereas 80 kg N, the minimum flag leaf area was recorded in rice genotype DXD (124)-3-30 (33.2 cm²) followed by DXD (124)-9-89 (33.3 cm²) and DXD (124)-1-12 (58.2 cm²) was found maximum flag leaf area followed by DXD (124)-2-20 (51.1 cm²) and DXD (124)-11-133 (49.2 cm²).

Under 40 kg N condition, the minimum flag leaf area was recorded in rice genotype DXD (124)-17-193 (20.2 cm²) followed by DXD (124)-17-210 (29.6 cm²), DXD (124)-2-17 and DXD (124)-9-89 (29.9 cm²) similarly. DXD (124)-1-12 (51.7 cm²) was found maximum flag leaf area followed by DXD (124)-2-20 (46.4 cm²).

S.No.	Name of rice genotypes	SLA (cm ² g ⁻¹)								
		2016			2017			Pooled		
		T1	T2	T3	T1	T2	T3	T1	T2	T3
1	DXD (124)-1-12	340.3	388.3	474.8	350.9	356.3	381.9	345.6	372.3	428.4
2	DXD (124)-1-14	389.4	224.8	248.4	205.0	207.3	250.0	297.2	216.1	249.2
3	DXD (124)-2-17	359.9	448.2	513.7	275.0	487.5	691.7	317.5	467.9	602.7
4	DXD (124)-2-20	356.4	437.9	511.5	400.0	399.9	633.3	378.2	418.9	572.4
5	DXD (124)-2-22	315.9	317.3	464.0	275.0	292.7	531.3	295.4	305.0	497.6
6	DXD (124)-3-28	286.1	285.8	334.2	260.0	263.3	455.6	273.0	274.5	394.9
7	DXD (124)-3-30	247.1	234.0	418.4	258.3	254.7	272.3	252.7	244.3	345.3
8	DXD (124)-3-59	348.5	410.8	410.5	358.3	368.4	363.3	353.4	389.6	386.9
9	DXD (124)-3-60	311.5	307.7	394.0	412.5	477.4	583.3	362.0	392.5	488.7
10	DXD (124)-4-70	383.6	382.5	426.6	337.5	347.6	416.7	360.6	365.0	421.6
11	DXD (124)-5-72	239.3	372.8	486.6	331.2	354.9	471.4	285.2	363.8	479.0
12	DXD (124)-6-74	291.6	352.9	391.4	275.7	324.4	321.1	283.7	338.7	356.3
13	DXD (124)-9-89	249.4	268.5	305.7	232.9	251.2	472.4	241.1	259.8	389.1
14	DXD (124)-9-91	202.6	217.1	328.0	262.3	263.5	402.2	232.5	240.3	365.1
15	DXD (124)-11-133	316.8	374.9	533.6	265.7	254.7	429.3	291.2	314.8	481.5
16	DXD (124)-15-164	147.8	162.8	185.7	185.1	155.7	452.1	166.4	159.2	318.9
17	DXD (124)-17-192	315.1	349.1	517.3	355.4	353.0	589.7	335.3	351.1	553.5
18	DXD (124)-17-193	163.6	196.4	311.6	267.4	284.6	358.4	215.5	240.5	335.0
19	DXD (124)-17-210	170.8	195.9	259.9	214.4	286.2	558.7	192.6	241.0	409.3
20	DXD (124)-17-211	136.7	175.9	202.2	213.0	266.0	361.1	174.9	220.9	281.7
	Treatment mean	278.6	305.2	385.9	286.8	312.5	449.8	282.7	308.8	417.8
	Factors	CD	SE	SE	CD	SE	SE	CD	SE	SE
			(d)	(m)		(d)	(m)		(d)	(m)
	Factor(N)	13.0	2.80	2.00	26.0	5.6	4.0	106.2	22.9	16.2
	Factor(G)	29.5	14.7	10.4	213.7	106.4	75.3	74.2	36.9	26.1
	GX N	51.9	25.4	8.9	370.6	184.4	17.8	N/A	64.0	42.5
	NX G	50.9	24.9	17.6	361.4	179.8	127.1	N/A	66.4	47.0

Table 6: Effect of Nitrogen levels on Specific leaf area (SLA) of rice (*Oryza sativa* L.).

Specific leaf area ($\text{cm}^2 \text{g}^{-1}$) under nitrogen treatment

The data on specific leaf area presented in Table 6. Significant differences were noted among different nitrogen treatments in relation to specific leaf area during both the years (2016-17 and 2017-18) but not in pooled data.

In case of 120 kg N condition, the minimum specific leaf area was recorded in rice genotype DXD (124)-15-164 ($166.4 \text{ cm}^2 \text{g}^{-1}$) followed by DXD (124)-17-211 ($174.9 \text{ cm}^2 \text{g}^{-1}$) and DXD (124)-2-20 ($378.2 \text{ cm}^2 \text{g}^{-1}$) was found maximum specific leaf area followed by DXD (124)-3-60 ($362 \text{ cm}^2 \text{g}^{-1}$), whereas 80 kg N, the minimum specific leaf area was recorded in rice genotype DXD (124)-15-164 ($159.2 \text{ cm}^2 \text{g}^{-1}$) followed by DXD (124)-1-14 ($216.1 \text{ cm}^2 \text{g}^{-1}$) and DXD (124)-2-17 ($467.9 \text{ cm}^2 \text{g}^{-1}$) was found maximum specific leaf area followed by DXD (124)-2-20 ($418.9 \text{ cm}^2 \text{g}^{-1}$).

Under 40 kg N condition, the minimum specific leaf area was recorded in rice genotype DXD (124)-1-14 ($249.2 \text{ cm}^2 \text{g}^{-1}$) followed by DXD (124)-17-211 ($281.7 \text{ cm}^2 \text{g}^{-1}$) and DXD (124)-2-17 ($602.7 \text{ cm}^2 \text{g}^{-1}$) was found maximum specific leaf area followed by DXD (124)-2-20 ($572.4 \text{ cm}^2 \text{g}^{-1}$) and DXD (124)-17-192 ($553.5 \text{ cm}^2 \text{g}^{-1}$).

Specific leaf weight (g cm^{-2}) under nitrogen treatment

The data on specific leaf weight presented in Table 7. No significant differences were noted among different nitrogen treatments in relation

to specific leaf weight during both the years (2016-17 and 2017-18) as well as in pooled data.

In case 120 kg N condition, the minimum specific leaf weight was recorded in rice genotype DXD (124)-17-192 (0.0031 g cm^{-2}) followed by DXD (124)-1-12 (0.0032 g cm^{-2}) and DXD (124)-15-164 (0.0061 g cm^{-2}) was found maximum specific leaf weight followed by DXD (124)-17-193 (0.0057 g cm^{-2}) whereas 80 kg N, the minimum specific leaf weight was recorded in rice genotype DXD (124)-2-17 (0.0022 g cm^{-2}) followed by DXD (124)-2-20 (0.0023 g cm^{-2}) and DXD (124)-15-164 (0.0056 g cm^{-2}) was found maximum specific leaf weight followed by DXD (124)-17-211 (0.0052 g cm^{-2}) and DXD (124)-17-210 (0.0051 g cm^{-2}).

In case 40 kg N condition, the minimum specific leaf weight was recorded in rice genotype DXD (124)-4-70 (0.0022 g cm^{-2}) followed by DXD (124)-11-133, DXD (124)-1-12, DXD (124)-2-20 (0.0023 g cm^{-2}) similarly and DXD (124)-15-164 (0.0054 g cm^{-2}) was found maximum specific leaf weight followed by DXD (124)-17-211 (0.0045 g cm^{-2}). Different growth and morphological parameters might be increased due to enhanced vegetative growth with increased application of N. The effect of nitrogen in the improvement of growth can be explained by the fact that nitrogen is ten main growth promoter element and helps for more synthesis of food resulting into greater cell division and cell enlargement [3].

S.No.	Name of rice genotypes	SLW (g cm^{-2})								
		2016			2017			Pooled		
		T1	T2	T3	T1	T2	T3	T1	T2	T3
1	DXD (124)-1-12	0.0033	0.0026	0.0021	0.0030	0.0026	0.0025	0.0031	0.0026	0.0023
2	DXD (124)-1-14	0.0056	0.0045	0.0040	0.0055	0.0045	0.0041	0.0056	0.0045	0.0041
3	DXD (124)-2-17	0.0038	0.0022	0.0022	0.0031	0.0022	0.0027	0.0034	0.0022	0.0024
4	DXD (124)-2-20	0.0028	0.0023	0.0020	0.0038	0.0023	0.0027	0.0033	0.0023	0.0023
5	DXD (124)-2-22	0.0038	0.0032	0.0022	0.0047	0.0032	0.0037	0.0042	0.0032	0.0029
6	DXD (124)-3-28	0.0045	0.0046	0.0030	0.0051	0.0046	0.0039	0.0048	0.0046	0.0035
7	DXD (124)-3-30	0.0049	0.0043	0.0024	0.0061	0.0043	0.0042	0.0055	0.0043	0.0033
8	DXD (124)-3-59	0.0029	0.0024	0.0024	0.0048	0.0024	0.0031	0.0038	0.0024	0.0028
9	DXD (124)-3-60	0.0035	0.0033	0.0025	0.0039	0.0033	0.0025	0.0037	0.0033	0.0025
10	DXD (124)-4-70	0.0026	0.0026	0.0023	0.0040	0.0026	0.0020	0.0033	0.0026	0.0022
11	DXD (124)-5-72	0.0040	0.0037	0.0021	0.0037	0.0037	0.0030	0.0038	0.0037	0.0026
12	DXD (124)-6-74	0.0034	0.0028	0.0026	0.0039	0.0028	0.0026	0.0037	0.0028	0.0026
13	DXD (124)-9-89	0.0040	0.0037	0.0033	0.0042	0.0037	0.0033	0.0041	0.0037	0.0033
14	DXD (124)-9-91	0.0050	0.0046	0.0031	0.0060	0.0046	0.0038	0.0055	0.0046	0.0034
15	DXD (124)-11-133	0.0034	0.0036	0.0019	0.0034	0.0031	0.0027	0.0034	0.0034	0.0023
16	DXD (124)-15-164	0.0062	0.0061	0.0054	0.0061	0.0051	0.0054	0.0062	0.0056	0.0054
17	DXD (124)-17-192	0.0032	0.0029	0.0019	0.0030	0.0029	0.0029	0.0031	0.0029	0.0024
18	DXD (124)-17-193	0.0058	0.0051	0.0032	0.0057	0.0051	0.0037	0.0058	0.0051	0.0035

19	DXD (124)-17-210	0.0057	0.0051	0.0039	0.0056	0.0051	0.0047	0.0057	0.0051	0.0043
20	DXD (124)-17-211	0.0052	0.0047	0.0043	0.0058	0.0057	0.0048	0.0055	0.0052	0.0046
	Treatment mean	0.0042	0.0037	0.0028	0.0046	0.0037	0.0034	0.0044	0.0037	0.0031
	Factors	CD	SE	SE	CD	SE	SE	CD	SE	SE
			(d)	(m)		(d)	(m)		(d)	(m)
	Factor(N)	N/A	0.00	0.001	N/A	0.001	0.001	N/A	0.001	0.000
	Factor(G)	0.00	0.00	0.001	0.001	0.001	0.001	0.001	0.001	0.000
	GX N	N/A	0.00	0.001	0.002	0.001	0.001	N/A	0.001	0.001
	NX G	N/A	0.00	0.001	0.002	0.001	0.001	N/A	0.001	0.001

Table 7: Effect of Nitrogen levels on Specific leaf weight (SLW) of rice (*Oryza sativa* L.).

Maximum number of tillers recorded under 120 kg N because, a direct correlation in the production of number of tillers and amount of the applied N fertilizer can be deduced. The number of tillers/m² responded to nitrogen fertilization at the increasing rate at all the observation stages. With the advancement in the age of rice crop, there was successively increase in the number of tillers/m² of the rate of nitrogen application. The increasing number of tillers and nitrogen may be attributed to the fact that nitrogen seems to have played a vital role in the formation of new tissues which are dependent on the protoplasmic structure. Moreover, increase of leaves/plant means increase in the photosynthesis surface area. In fact, leaf is the factory for the conversion of energy in to the chemical energy by the process of photosynthesis [4,5]. Number of tillers per unit area is the most important component of yield. More tiller number was due to the increase in the availability, absorption and accumulation of N by the rice plants. Nitrogen deficiency led to reduction in the number of tillers as well as in the number of productive tillers which in turn had a negative effect on dry matter production and yield [6].

In rice, Number of panicles per unit area is primary yield determining component. For achieving higher yield in rice, the sink size should be increased by increasing panicle size or number or either. The cultivar having large panicles may be the best option but the adequate numbers of panicles need to be maintained properly in terms of sink-source balance [7,8].

Present investigation found that 120 kg N has a maximum flag leaf area as compared to other treatment in all the genotypes. These is because due to, Nitrogen is associated with protoplasm synthesis and vigorous vegetative growth due to increased cell division and cell elongation. Hence, application of nitrogen resulted in the significant increase in leaf area over no nitrogen [9].

In the present investigation found that higher SLA recorded under 40 kg N because it consists minimum leaf area as compared to other. At a cellular level, N increases the cell number and cell volume; at the leaf level, it increases the photosynthetic rate and efficiency. Increases in crop growth rate are largely produced through an increase in leaf area index, and also by an increase in radiation use efficiency.

Conclusion

In conclusion, effect of different nitrogen level on growth and morpho-physiological parameters of rice was positive and higher doses of nitrogen gives better result compared to other, also found that 80 kg N also gives maximum result which is similar to 120 kg N but 40 kg N not give significant result compared to others.

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