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Effect of different genotypes and nitrogen levels on grain yield and quality of rice

Sivasabari K[1*], S Jothimani[2] and R Ajaykumar[3]

[1]Department of Soil Science and Agricultural Chemistry, TNAU, Coimbatore -641003
[2]Department of Soil Science and Agricultural Chemistry, TNAU, Killikulam-628252
[3]Department of Agronomy, TNAU, Coimbatore-641003, Tamil Nadu, India
Corresponding author e-mail: sabarisiva3@gmail.com

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Abstract

Rice (*Oryza sativa* L.) is the only cereal crop cooked and consumed mainly as whole grains, and quality considerations are much more important than for any other food crop. Nevertheless, rice-grain quality depends not only on genetic background, but also on soil and climatic conditions, agronomic treatments during rice growth and development. Levels of nitrogen more easily affects rice growth and rice grain quality. A field experiment was conducted in split plot design comprised of thirty-two rice genotypes as main plots and four N levels (N_0 (control), N_1 (50 % RDN), N_2 (100 % RDN) and N_3 (150 % RDN) as sub-plots with three replications to assess the grain quality and cooking properties of rice. Highest grain yield were recorded at N_3 (180 kg ha^{-1}) by most of the rice genotypes, except AS 12051, ACK 14004, CB08702, CB 13539 and PM 12009 which have not responded for higher dose of nitrogen (180 kg ha^{-1}). Kernel length and kernel breadth before and after cooking was significantly influenced in the rice genotypes. EC725224 (G_{32}) exhibited highest mean length of 7.10 mm before cooking which elongated to 10.47 mm after cooking. All the rice genotypes showed a kernel breadth of less than 2.0 mm and considered as best. The highest mean amylose content of 26.11 % was obtained from the genotype TM09135 (G_{26}) followed by EC725224 (G_{32}) which recorded the mean amylose content of 24.91 % in rice.

Keywords: Rice genotypes, nitrogen, rice quality, kernel length, kernel breadth, amylose

Introduction

Rice (*Oryza sativa* L.) is the staple food for over half of the world population and it is ranked as the number one human food crop in world (Itani *et al*., 2002). More than 90% of world rice is grown and consumed in Asia (Tyagi *et al*., 2004), whereas 60% calories are consumed by 3 billion Asians. India is the second most populous nation, stands first in area, second in production of rice followed and preceded by China. Rice occupies a pivotal place in Indian food and livelihood security system. It provides about 75% of the average calories and 55 % of the protein in the average daily diet of the people (Anonymous, 2002). In India, rice occupies 44.6 m ha. Rice is the only cereal crop cooked and consumed mainly as whole grains, and quality considerations are much more important than for any other food crop (Hossain *et al*., 2009). Among the various cultural practices, fertilizer management is crucial factor, which influence the growth and yield of rice. A significant variation due to fertilizer levels was noticed in all the quality parameters. However, due to the pressure of grain supply, less attention is paid to improve rice-grain quality. With continuous economic development and rising standards of living, a preference for high grain quality gradually increases. Thus, improving rice quantity and quality is not only closely associated with the improvement of people's living conditions, but it is also a major response measure for ensuring world food security under extreme climate change and tremendous population growth. Many studies have reported on the genetic control of rice cultivar on the grain-shape, appearance-quality (Zhao *et al*., 2018), gel-consistency, gelatinization-temperature (Bao *et al*., 2002; He *et al*., 1999), and pasting-viscosity parameters (Bao, 2012). Bao *et al*. (2004) suggested that amylose content; final viscosity, breakdown, and setback were mainly influenced by genotypic variance.

Nevertheless, rice-grain quality depends not only on genetic background, but also on soil and climatic conditions, and agronomic treatments during rice growth and development. However, to date, information on how crop-management practices affect rice-grain quality is lacking. Giving more importance to genetic diversity in rice-breeding programs is crucial to improve rice quality, but this improvement could be seriously restricted in the absence of appropriate agricultural approaches. Thus, it is imperative to simultaneously consider genetic and management practices to achieve the target amelioration of rice-grain quality. Nitrogen (N) rate is key factor that affects rice-grain quality and growth of rice. Research in this field is of great significance not only for breeders, but also for producers, and has a direct effect on the production of high-quality grains. Our objective was to determine the effect of genotype and N application rates on rice-grain quality and to provide useful knowledge for achieving high-quality rice production.

Materials and Methods

A field experiment was conducted during *pishanam* season, 2017 at Agricultural Research Farm, Rice Research station, Ambasamudram, Tirunelveli, Tamil Nadu with split plot design comprising of thirty two rice genotypes *viz*. ASD16, ADT39, ADT43, ADT45, CO51, TPS5, MDU5, ANNA4, AS12051, AS12104, AD09206, AD10034, ACK14001, ACK14004, CB06803, CB08702, CB13539, CB14508, CB14533, TR09027, TR05031, TR13069, TR13083, TM13007, TM07335, TM09135, TM10085, TM12059, TM12061, TM12077, PM12009 and EC725224 as main plots and four N levels (N_0 (control), N_1 (50 % RDN), N_2 (100 % RDN) and N_3 (150 % RDN) as sub-plots with three replications to assess the grain quality and cooking properties of rice **(Table 1).** All the recommended package of practices were followed to raise a good crop. The nursery was raised separately for 32 different rice genotypes. The nursery for SRI was prepared as raised beds with dimension of 120 cm wide, 15 cm height including buffer channel half meter wide all round them to facilitate easy drainage. The water soaked seeds of rice genotypes were sown evenly in the line. Hand weeding also practiced to remove the weeds in the adjoining areas of rice haulm / plants at 45 and 60 DAT. The plots were irrigated with 2.5 cm depth of water and irrigated again on appearance of hairline cracks on the soil surface. This practice was continued till the flowering stage of the crop. The entire dose of P_2O_5 was applied as single super phosphate before planting. The one split dose of potassium was applied as muriate of potash (among four equal split doses) before planting and other 3 splits were applied at tillering (30 DAT), panicle initiation (60 DAT) and flowering stage (75 DAT). The N fertiliser (urea) was applied as per the treatment schedule. The urea was applied in four equal split doses during before planting (basal 25 %) and top dressing at tillering at 30 DAT (25 %), panicle initiation at 60 DAT (25 %) and flowering stage at 75 DAT (25 %). Data pertaining to different quality traits *viz*. kernel length, kernel breadth, kernel length after cooking, kernel breadth after cooking, size and shape of grain were recorded on five randomly selected grains of each replication. A simplified procedure was used for estimating the amylose content (Juliano 1971). Based on amylose content the rice was categorized as waxy, verylow, low, intermediate and high (**Table 2**; SES, 2002).

Results and Discussion

Grain yield

The results of the field experiment revealed that the grain yield of rice was significantly influenced by genotypes, nitrogen levels and their interaction. Among the genotypes, the highest grain yield of 6698 kg ha^{-1} was recorded by ASD16 which was on par with 6695 kg ha^{-1} recorded by TR13083 followed by TM12077 which produced the grain yield of 6162

Table 1: Details of the rice varieties/cultures

Factors	Genotype	Parentage	Variety / Cultivar	Duration (Short, medium, long)
Main plot (Rice genotypes)	ASD 16	ADT31xCO39	V	Short duration rice cultivars
	ADT 39	IR8 x IR20	V	
	ADT 43	IR50xwhite ponni	V	
	ADT 45	IR50 /ADT37	V	
	CO 51	ADT43xRR272-1745	V	
	TPS 5	ASD16 x ADT37	V	
	MDU 5	O.glaberrima x Pokkali	V	
	ANNA 4	Pantdhan10 x IET9911	V	
	AS 12051	BPT5204/ASD16	C	
	AS 12104	ADT(R) 45 / Raskadam	C	
	AD 09206	ADT43/ADT37	C	
	AD 10034	ADT(R) / Swarna	C	
	ACK 14001	ACK9009 / ASD16	C	
	ACK 14004	IR8 / ASD16	C	
	CB 06803	PMK(R) 3/Norungan	C	
	CB 08702	IR80013-B-141-4	C	
	CB 13539	ADT43/GEB24	C	
	CB 14508	ADT37/CB05501	C	
	CB 14533	Bhavani/CB05501	C	
	TR 0927	Mutant of TRY(R) 2	C	
	TR 05031	ADT39/CO45	C	
	TR 13069	ADT43 / FL478 /ADT43	C	
	TR 13083	ADT43 / FL478/ADT43	C	
	TM 13007	TKM13 x IET22565	C	
	TM 07335	ADT43 / CO47	C	
	TM 09135	IR82639-B-B-115-1	C	
	TM 10085	ADT43/CO47	C	
	TM 12059	ADT(R)45/Chandihar	C	
	TM 12061	Senthooram/Vandana	C	
	TM 12077	TKM (R)12 x IET21620	C	
	PM 12009	IR55419-4*2/way rarem	C	
	EC 725224	Philippine culture	C	

Table 2: Classification of rice genotypes based on size and shape of kernel

Length	Size	Amylose	Category
>7.50	Extra long	<0.00 to 2.00	Waxy
6.61to 7.50	Long	3.01 to 9.00	Very low
5.51 to 6.60	Medium	10.01 to 19.00	Low
5.5 or less	Short	20.00 to 25.00	Intermediate
		>25.00	High

kg ha^{-1} **(Table 3).** The lowest grain yield of 2433 kg ha^{-1} was observed in the genotype CB14533. With regards to nitrogen levels, increased mean grain yield of 4916, 5548 and 6072 kg ha^{-1} were recorded by the application of 50 % recommended dose of nitrogen (60 kg ha^{-1}), 100 % recommended dose of nitrogen (120 kg N ha^{-1}) and 150 % recommended dose of nitrogen (180 kg N ha^{-1}) than control (N_0) which yielded 4111 kg ha^{-1} of rice grains. The interaction effect between the nitrogen levels and rice genotypes significantly influenced the grain yield. The highest grain yield of 8150 kg ha^{-1} was observed under ASD16 with the application of 150 % recommended dose of nitrogen (G_1N_3) followed by TR13083 grown under same dose of nitrogen (180 kg N ha^{-1}) which produced 7333 kg ha^{-1} of grain yield. The lowest grain yield (1543 kg ha^{-1}) was obtained by the genotype CB14533 without nitrogen application (absolute control) followed by TR09027 which yielded 2878 kg ha^{-1} of grain. In all the genotypes, the grain yield increased from control due to the application of higher dose of nitrogen (180 kg N ha^{-1}) except AS12051, ACK14004, CB08702, CB13539 and PM12009. These genotypes recorded highest grain yield of 5864, 5536, 5287, 4754 and 3750 kg ha^{-1}at 100% recommended dose of nitrogen and the yield decreased at higher dose of 180 kg N ha^{-1} (150 % recommended dose of N).

A significant positive correlation observed between N uptake and dry matter production at tillering and panicle initiation **(Figure 1)** suggested maintaining N concentration on leaves during early vegetative stage is compulsory for maintaining higher biomass and yield. The uptake of nitrogen and utilization of absorbed N efficiently converted product of biomass production at tillering, panicle initiation and heading stages. Application of 150 % recommended dose of nitrogen (N_3) showed higher soil available nitrogen at tillering, panicle initiation, heading and harvest stages of rice (323, 295, 263 and 224 Kg ha^{-1}). The lowest soil available nitrogen (260, 231. 203 and 167 Kg ha^{-1}) was recorded under control at phenological stages of rice **(Figure 2).** The soil available N and the amount of N depletion are directly related and the amount of N addition and amount of N depletion is indirectly related with each other. The highest N depletion of 35.76 % was recorded under control and the lowest depletion of 30.65 % was recorded under N_{150}. Higher nitrogen content in soil after harvest reflected the higher dose of N application to the soil. This result is in agreement with findings of Majumdar (2005) and Roy *et al*., (2006). However, during the crop growth period the reduction in the soil available N could be attributed to the uptake by growing crop (Scandaliaris *et al*., 1987).

Kernel length and breadth

The quality parameters of kernel length and kernel breadth before and after cooking significantly influenced by the rice genotypes. EC725224 (G_{32}) exhibited highest mean length of 7.10 mm before cooking which elongated to 10.47 mm after cooking. Based on the standard system of evaluation of rice kernels, the rice genotypes AS16, ADT39, ADT43, TPS5, AS12051, AS12104, AD09206, AD10034, ACK14001, ACK14004, CB06803, CB13539, Cb14508, TR05031, TR13069, TM07335, TM10085, TM12059, TM12061 and TM12077 were categorized as shorter kernel varieties whereas the genotypes such as ADT45, CO51, MDU5, ANNA4, CB08702, CB14533, TR09027, TR13007, TM12009 and TM09135 as medium kernel varieties and the genotype EC725224 as long kernel variety **(Table 3 and 4)**. The varieties with kernel breadth of less than 2.0 mm are considered as best category rice genotypes (Singh *et al*., 2012). In this experiment, all the rice genotypes showed a kernel breadth less than 2.0 mm **(Table 5,6 and 7).** The quality parameters of kernel length and kernel breadth before and after cooking increased with increasing level of nitrogen which may be due to the fact that nitrogen is the principal constituent of protein. This is in corroboration with the findings of Subudhi *et al*., (2012).

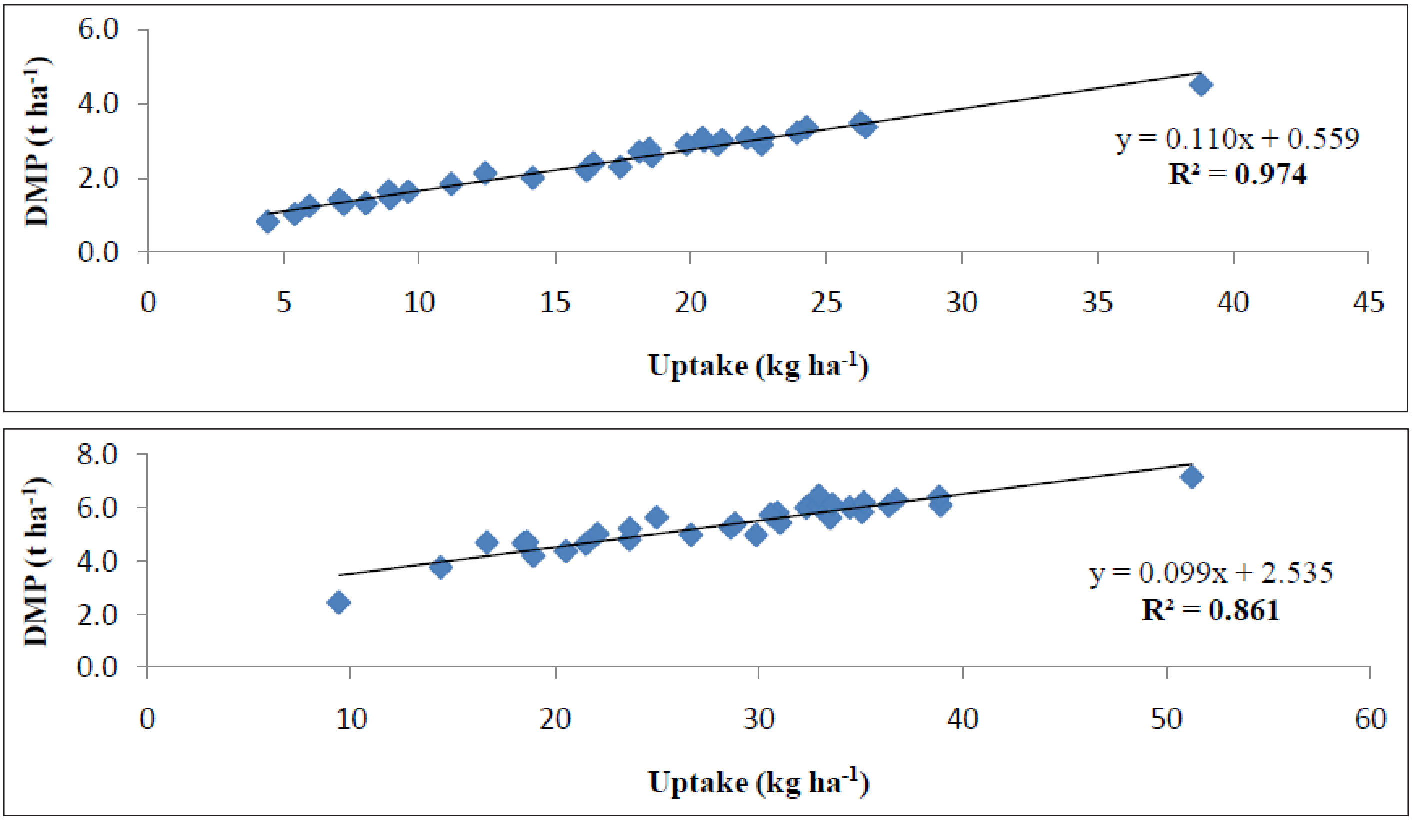

Figure 1: Regression between nitrogen uptake and dry matter production as influenced by rice genotypes at tillering and panicle initiation

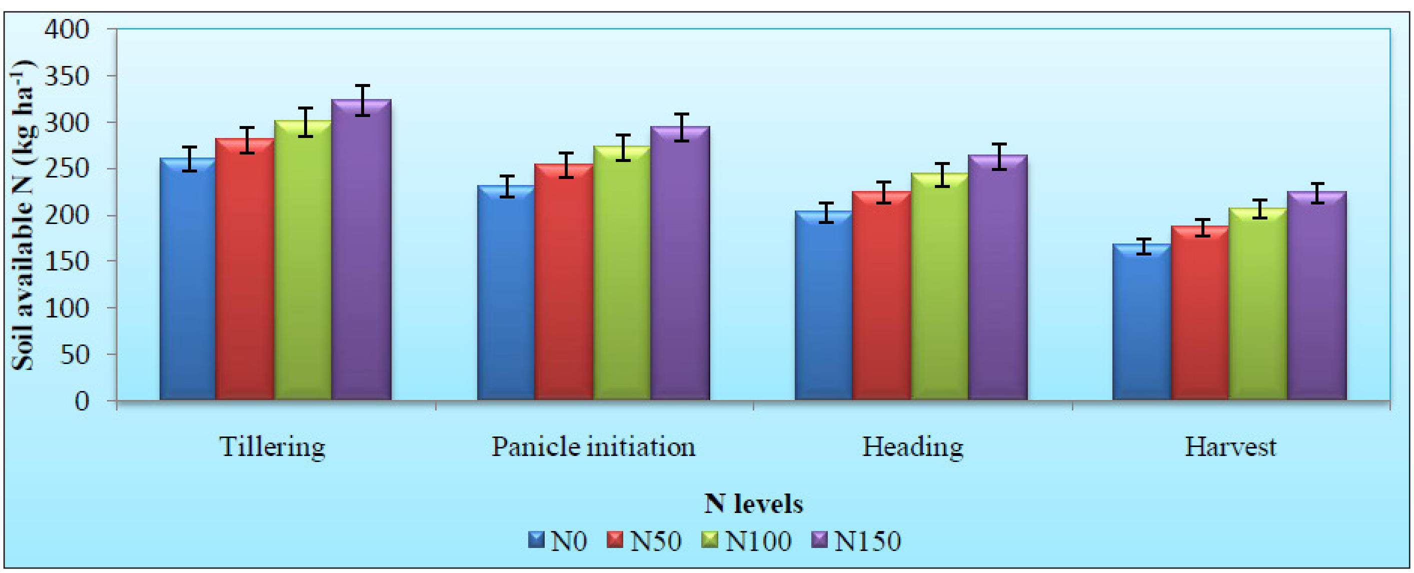

Figure 2: Soil available N as influenced by the levels of N application at different stages of rice

Table 3: **Grain yield (kg ha^{-1}) of rice influenced by genotypes and levels of nitrogen application**

S.No	Genotypes/ Varieties	N_0	N_1	N_2	N_3	Mean
1	ASD 16	5284	6175	7183	8150	6698
2	ADT 39	3682	4921	5778	6814	5299
3	ADT 43	4259	4691	5500	6723	5293
4	ADT 45	4606	5339	6299	7256	5875
5	CO 51	4587	4940	5576	6371	5368
6	TPS 5	3643	4660	5550	5924	4944
7	MDU 5	5549	5660	6188	6659	6014
8	ANNA 4	5289	5355	5512	5577	5433
9	AS 12051	3889	4410	4754	4681	4433
10	AS 12104	4556	5493	6226	6428	5676
11	AD 09206	3254	4374	4969	5372	4492
12	AD 10034	4968	5317	5390	5497	5293
13	ACK 14001	4837	5844	6678	6929	6072
14	ACK 14004	4510	5549	5864	5771	5423
15	CB 06803	3536	4775	5542	6012	4966
16	CB 08702	4335	4811	5287	5078	4878
17	CB 13539	3029	3401	3750	3429	3402
18	CB 14508	4350	5156	6144	7051	5675
19	CB 14533	1543	2030	2526	4420	2629
20	TR 0927	2878	3291	4294	5107	3892
21	TR 05-31	4632	5895	6275	6717	5880
22	TR 13069	3811	4204	4795	5873	4671
23	TR 13083	5778	6479	7188	7333	6695
24	TM 1307	5056	5762	6220	6627	5916
25	TM 07335	4947	5495	6209	6862	5878
26	TM 09135	3660	4594	4890	5502	4661
27	TM 10085	3673	5015	6051	7157	5474
28	TM 12059	3868	4587	5085	5512	4763
29	TM 12061	2911	3322	4542	5438	4053
30	TM 12077	4304	6020	7119	7206	6162
31	PM 12009	3372	5222	5536	5418	4887
32	EC 725224	2956	4517	4611	5419	4376
	Mean	**4111**	**4916**	**5548**	**6072**	**5162**
		G	**N**	**G x N**	**N x G**	
	SE d	30.34	11.16	62.53	63.13	**-**
	CD	61.84	22.15	124.92	125.31	**-**

Table 4. Kernel length before cooking (mm) of rice genotypes as influenced by nitrogen application

S.No	Treatments	N_0	N_{50}	N_{100}	N_{150}	Mean
1	ASD 16	5.30	5.33	5.34	5.36	5.33^{m}
2	ADT 39	5.18	5.24	5.27	5.43	5.28^{no}
3	ADT 43	5.33	5.35	5.42	5.49	5.40^{l}
4	ADT 45	6.07	6.13	6.15	6.18	6.13^{f}
5	CO 51	5.46	5.55	5.64	5.72	5.59^{i}
6	TPS 5	4.97	5.33	5.48	5.48	5.31^{n}
7	MDU 5	6.10	6.11	6.13	6.15	6.12^{f}
8	ANNA 4	6.16	6.21	6.41	6.50	6.32^{c}
9	AS 12051	5.26	5.25	5.71	5.76	5.49^{k}
10	AS 12104	5.00	5.06	5.11	5.15	5.08^{u}
11	AD 09206	5.04	5.15	5.29	5.41	5.22^{pq}
12	AD 10034	5.09	5.21	5.24	5.26	5.20^{qrs}
13	ACK 14001	5.22	5.25	5.25	5.28	5.25^{op}
14	ACK 14004	5.05	5.12	5.37	5.37	5.22^{pq}
15	CB 06803	5.00	5.43	5.44	5.48	5.33^{m}
16	CB 08702	5.87	6.33	6.57	6.57	6.33^{c}
17	CB 13539	5.12	5.17	5.21	5.24	5.18^{rst}
18	CB 14508	5.06	5.13	5.19	5.24	5.15^{t}
19	CB 14533	5.66	5.69	5.87	5.89	5.77^{h}
20	TR09027	6.15	6.22	6.30	6.42	6.27^{d}
21	TR05031	5.04	5.14	5.23	5.33	5.18^{rst}
22	TR 13069	5.33	5.36	5.48	5.80	5.49^{k}
23	TR 13083	5.44	5.49	5.63	5.67	5.55^{j}
24	TR13007	5.97	6.00	6.05	6.05	6.02^{g}
25	TM 07335	4.75	4.83	4.97	4.98	4.88^{v}
26	TM 09135	6.35	6.37	6.56	6.72	6.50^{b}
27	TM 10085	4.76	4.77	4.99	5.05	4.89^{v}
28	TM 12059	4.92	5.06	5.22	5.47	5.16^{st}
29	TM 12061	5.22	5.24	5.27	5.33	5.26^{o}
30	TM 12077	5.15	5.21	5.24	5.25	5.21^{qr}
31	PM 12009	6.07	6.21	6.23	6.34	6.21^{e}
32	EC 725224	6.95	7.17	7.14	7.17	7.10^{a}
	Mean	**5.30^{d}**	**5.33^{c}**	**5.34^{b}**	**5.36^{a}**	**5.33**
		G	**N**	**G × N**	**N× G**	
	SE d	0.01	0.006	0.03	0.03	
	CD (P =0.05)	0.03	0.012	0.06	0.07	

Table 5. Kernel length after cooking (mm) of rice genotypes as influenced by nitrogen application

S.No	Treatments	N_0	N_{50}	N_{100}	N_{150}	Mean
1	ASD 16	8.74	8.84	8.84	8.75	8.79^{e}
2	ADT 39	8.63	8.64	8.67	8.66	8.65^{h}
3	ADT 43	8.55	8.56	8.66	8.67	8.61^{i}
4	ADT 45	8.11	8.14	8.18	8.18	8.15^{m}
5	CO 51	8.36	8.38	8.41	8.45	8.40^{k}
6	TPS 5	7.07	7.72	7.78	7.83	7.60^{u}
7	MDU 5	8.19	8.23	8.24	8.27	8.23^{l}
8	ANNA 4	8.52	8.57	8.61	8.62	8.58^{i}
9	AS 12051	7.73	7.75	8.08	8.14	7.92^{o}
10	AS 12104	7.04	7.06	7.12	7.18	7.10^{x}
11	AD 09206	7.64	7.68	7.72	7.73	7.69^{s}
12	AD 10034	7.61	7.75	7.74	7.79	7.72^{rs}
13	ACK 14001	7.82	7.85	7.88	7.90	7.86^{p}
14	ACK 14004	7.67	7.75	7.80	7.81	7.75^{q}
15	CB 06803	7.56	7.74	7.78	7.81	7.72^{rs}
16	CB 08702	8.04	8.62	8.75	8.76	8.54^{j}
17	CB 13539	7.52	7.58	7.67	7.68	7.61^{u}
18	CB 14508	7.02	7.09	7.18	7.24	7.13^{w}
19	CB 14533	6.83	6.88	7.01	7.11	6.95^{y}
20	TR09027	8.82	8.92	8.98	8.98	8.92^{d}
21	TR05031	7.57	7.63	7.69	7.75	7.66^{t}
22	TR 13069	8.57	8.62	8.77	8.78	8.68^{g}
23	TR 13083	7.87	7.92	8.02	8.08	7.97^{n}
24	TR13007	8.71	8.78	8.78	8.78	8.76^{f}
25	TM 07335	5.76	5.88	5.94	5.96	5.88^{z}
26	TM 09135	9.45	9.46	9.50	9.62	9.50^{c}
27	TM 10085	7.22	7.26	7.47	7.68	7.40^{v}
28	TM 12059	7.76	8.29	8.35	8.41	8.20^{l}
29	TM 12061	7.70	7.72	7.74	7.78	7.73^{q}
30	TM 12077	7.53	7.59	7.64	7.65	7.60^{u}
31	PM 12009	9.52	10.20	10.23	10.28	10.05^{b}
32	EC 725224	9.85	10.65	10.67	10.73	10.47^{a}
	Mean	**7.97^{d}**	**8.11^{c}**	**8.18^{b}**	**8.22^{a}**	**8.12**
		G	**N**	**G × N**	**N× G**	
	SE d	0.01	0.003	0.02	0.02	
	CD (P =0.05)	0.03	0.006	0.04	0.04	

Table 6. Kernel breadth before cooking (mm) of rice genotypes as influenced by nitrogen application

S.No	Treatments	N_0	N_{50}	N_{100}	N_{150}	Mean
1	ASD 16	1.42	1.46	1.45	1.45	1.45[d]
2	ADT 39	1.12	1.17	1.19	1.19	1.17[pq]
3	ADT 43	1.09	1.15	1.21	1.25	1.17[p]
4	ADT 45	1.24	1.26	1.34	1.35	1.29[i]
5	CO 51	1.10	1.13	1.19	1.21	1.16[q]
6	TPS 5	1.23	1.41	1.43	1.52	1.40[e]
7	MDU 5	1.46	1.46	1.49	1.51	1.48[c]
8	ANNA 4	1.33	1.36	1.35	1.36	1.35[h]
9	AS 12051	1.23	1.25	1.26	1.31	1.26[j]
10	AS 12104	1.14	1.17	1.19	1.20	1.17[pq]
11	AD 09206	1.19	1.18	1.17	1.18	1.18[p]
12	AD 10034	1.01	1.09	1.09	1.09	1.07[r]
13	ACK 14001	1.47	1.52	1.60	1.62	1.52[a]
14	ACK 14004	1.29	1.28	1.27	1.34	1.29[i]
15	CB 06803	1.44	1.47	1.55	1.56	1.50[b]
16	CB 08702	1.36	1.35	1.39	1.43	1.38[f]
17	CB 13539	1.16	1.19	1.22	1.28	1.21[no]
18	CB 14508	1.47	1.47	1.51	1.52	1.49[bc]
19	CB 14533	1.21	1.27	1.27	1.28	1.26[j]
20	TR09027	1.16	1.18	1.26	1.32	1.23[lm]
21	TR05031	1.14	1.15	1.18	1.22	1.17[pq]
22	TR 13069	1.25	1.27	1.30	1.35	1.29[i]
23	TR 13083	1.25	1.25	1.27	1.31	1.27[j]
24	TR13007	1.24	1.25	1.22	1.25	1.24[kl]
25	TM 07335	1.14	1.17	1.19	1.19	1.17[pq]
26	TM 09135	1.31	1.34	1.42	1.43	1.37[fg]
27	TM 10085	1.19	1.26	1.27	1.30	1.25[jk]
28	TM 12059	1.20	1.21	1.22	1.26	1.22[mn]
29	TM 12061	1.17	1.19	1.22	1.24	1.20[o]
30	TM 12077	1.09	1.10	1.11	1.41	1.18[p]
31	PM 12009	1.33	1.41	1.42	1.44	1.40[e]
32	EC 725224	1.32	1.34	1.37	1.43	1.36[gh]
	Mean	**1.24[d]**	**1.27[c]**	**1.30[b]**	**1.33[a]**	**1.28**
		G	**N**	**G × N**	**N× G**	
	SE d	0.007	0.002	0.01	0.01	
	CD (P =0.05)	0.014	0.005	0.03	0.03	

Table 7. Kernel breadth after cooking of rice genotypes as influenced by nitrogen application

S.No	Treatments	N_0	N_{50}	N_{100}	N_{150}	Mean
1	ASD 16	1.52	1.96	2.40	2.43	2.08[d]
2	ADT 39	1.22	1.67	2.14	2.17	1.80[pq]
3	ADT 43	1.19	1.65	2.16	2.23	1.81[p]
4	ADT 45	1.34	1.76	2.29	2.33	1.93[i]
5	CO 51	1.20	1.63	2.14	2.19	1.79[q]
6	TPS 5	1.33	1.91	2.38	2.50	2.03[e]
7	MDU 5	1.56	1.96	2.44	2.49	2.11[c]
8	ANNA 4	1.43	1.86	2.30	2.34	1.98[h]
9	AS 12051	1.33	1.75	2.21	2.29	1.89[j]
10	AS 12104	1.24	1.67	2.14	2.18	1.80[pq]
11	AD 09206	1.29	1.68	2.12	2.16	1.81[p]
12	AD 10034	1.11	1.59	2.04	2.07	1.70[r]
13	ACK 14001	1.57	2.02	2.48	2.55	2.15[a]
14	ACK 14004	1.39	1.78	2.22	2.32	1.93[i]
15	CB 06803	1.54	1.97	2.50	2.54	2.13[b]
16	CB 08702	1.46	1.85	2.34	2.41	2.01[f]
17	CB 13539	1.26	1.69	2.17	2.26	1.84[no]
18	CB 14508	1.57	1.97	2.46	2.50	2.12[bc]
19	CB 14533	1.31	1.77	2.22	2.26	1.89[j]
20	TR09027	1.26	1.68	2.21	2.30	1.86[lm]
21	TR05031	1.24	1.65	2.13	2.20	1.80[q]
22	TR 13069	1.35	1.77	2.25	2.33	1.92[i]
23	TR 13083	1.35	1.75	2.22	2.29	1.90[j]
24	TR13007	1.34	1.75	2.17	2.23	1.87[l]
25	TM 07335	1.24	1.67	2.14	2.17	1.80[pq]
26	TM 09135	1.41	1.84	2.37	2.41	2.00[fg]
27	TM 10085	1.29	1.76	2.22	2.28	1.89[jk]
28	TM 12059	1.30	1.71	2.17	2.24	1.85[mn]
29	TM 12061	1.27	1.69	2.17	2.22	1.83[o]
30	TM 12077	1.19	1.60	2.06	2.39	1.81[p]
31	PM 12009	1.43	1.91	2.37	2.42	2.03[e]
32	EC 725224	1.42	1.84	2.32	2.41	1.99[gh]
	Mean	**1.34[d]**	**1.77[c]**	**2.25[b]**	**2.31[a]**	**1.92**
		G	**N**	**G × N**	**N× G**	
	SE d	0.007	0.002	0.01	0.01	
	CD (P =0.05)	0.014	0.005	0.03	0.03	

Amylose content

Amylose content is the major factor for judging eating quality (Juliano and Hicks, 1996). It determines the hardness or stickiness of cooked rice, cohesiveness, tenderness, colour of cooked rice etc. The higher amylose content (>25.0%) gives non sticky soft or hard cooked rice. Rice varieties having 20-25% amylose content gives soft and flaky cooked rice. It was also used as an indicator of volume expansion on water absorption during cooking (Denyer *et al*., 2001). Intermediate amylose content (20-25%) is usually preferred by Indians. In this study, all the tested genotypes had intermediate amylose content except EC725224. Among the genotypes, the highest mean amylose content of 26.11 % was obtained from the genotype TM09135 (G_{26}) followed by EC725224 (G_{32}) which recorded the mean amylose content of 24.91 % in rice. The lowest mean amylose content of 19.55 % was recorded in the genotype TR13069 (G_{22}) **(Figure 3).**

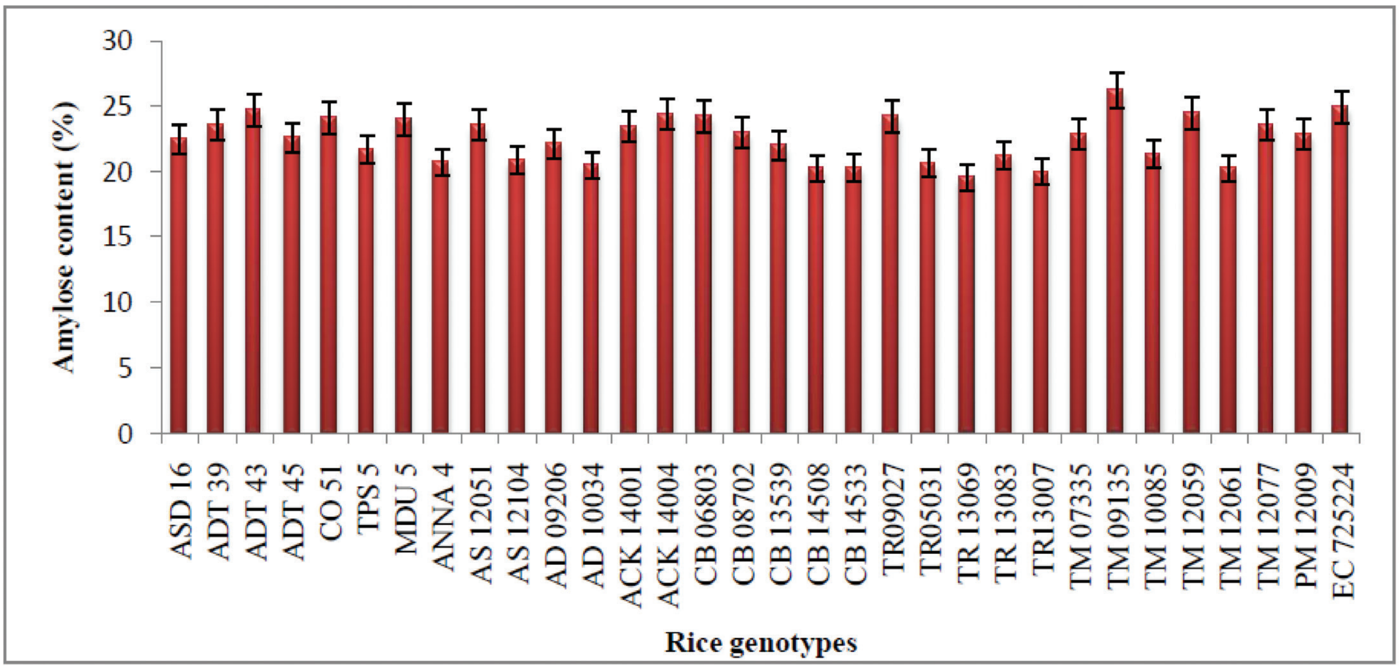

Figure 3: Amylose content (%) as influenced by rice genotypes

Amylose content decreased with increased level of nitrogen application in the study **(Figure 4).** It might be due to increase in the activation of starch branching enzymes and as a result amylopectin percentage increased and amylose content decreased (Zadeh and Hashemi, 2014). With respect to nitrogen levels, the highest mean amylose content of 23.63 was observed under control followed by the application of 50 % recommended dose of nitrogen (23.11 %). The lowest amylose content of 21.32 % was observed by the application of 150 % recommended dose of nitrogen. Among the interaction, the highest amylose content of 27.75 % present in the genotype TM09135 under no nitrogen application followed by 26.95 % was recorded by the same genotype under 50 % recommended dose of nitrogen. The minimum quantity of 16.56 % was observed by the genotype ANNA4 with 150 % recommended dose of nitrogen (G_8N_3). This result was in conformity with the reported work of Dong *et al*., (2007).

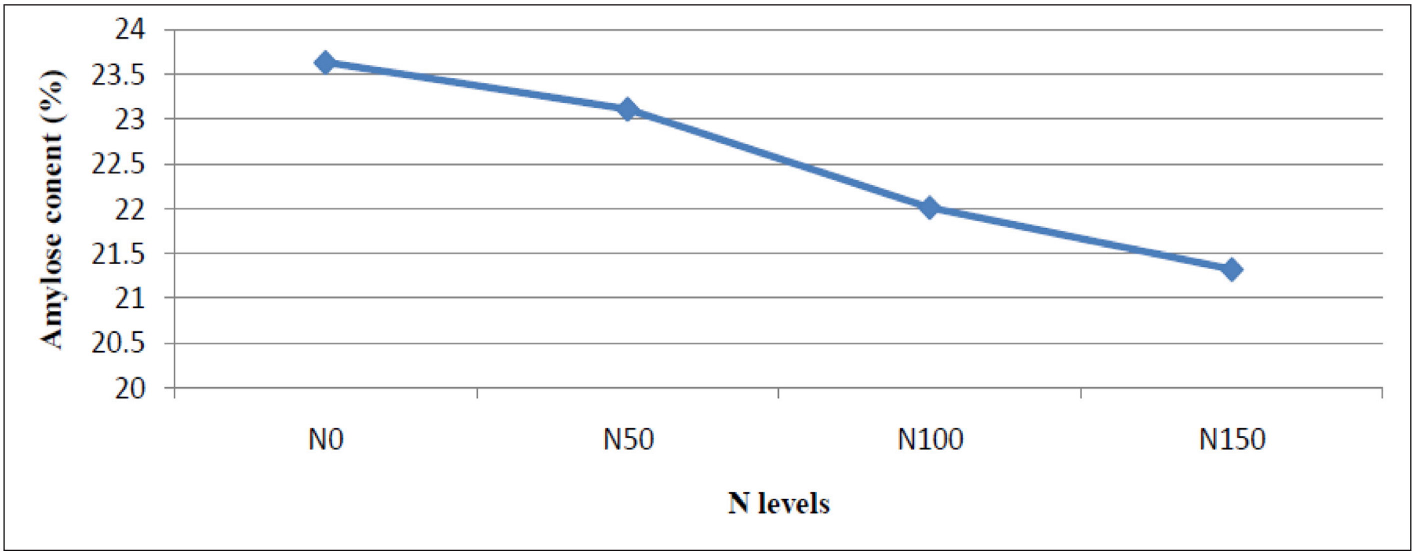

Figure 4: Amylose content (%) as influenced by levels of nitrogen application

Conclusion

This study conducted on 32 rice genotypes collected from Tamilnadu, revealed the variability of genotypes and nitrogen application on their physical and chemical characteristics. Genotypes were highly significant in physical and chemical characteristics such as shape and amylose content of the rice. High variation among the rice genotypes was obtained in the characteristics like grain yield, kernel length, kernel breadth and amylose content. Some of the genotypes showed noble physico-chemical characteristics that can fetch premium prices especially the exotic variety EC725224 showed higher length and breadth before and after cooking and it is mainly used for biryani making. Based on the amylose content we can conclude the storage determination for rice taste. Amylose and amylopectin determines the cooking quality of rice. Indians mostly prefer non sticky rice varieties which have higher amylose content of 25% - 30%, when it will be stored the amylose content gets reduced and the rice will become soft. So, most of the consumers prefer old rice. The information obtained through this study could be used in rice breeding programmes and molecular research for further improvement of rice and it may help food processors to produce a good quality of cooked rice by controlling the amylose content.

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