

YIELD AND YIELD ATTRIBUTES ARE INFLUENCED BY THE DIFFERENT NITROGEN LEVELS IN RICE GENOTYPES

Abstract

The experiment was conducted during 2017, *pishanam* season at Rice Research Station, Ambasamudram with the objective to screen the efficient and responsive rice genotypes based on nitrogen use efficiency and yield and yield attributes of different genotypes by N levels ~~with under~~ 32 rice genotypes as main plot treatments and four nitrogen levels N₀ (control), N₁ (50% recommended dose of N ha⁻¹), N₂ (100% recommended dose of N ha⁻¹) and N₃ (150% recommended dose of N ha⁻¹) as subplot treatments. The experimental results showed that, the highest grain and straw yields were recorded at N₃ (180 kg ha⁻¹) by the most of the rice genotypes, except the AS 12051, ACK 14004, CB08702, CB 13539 and PM 12009 which were not responded genotypes for higher dose of (180 kg ha⁻¹) nitrogen. In the genotypes ASD 16, ADT 43, ADT 45, CO 51, MDU 5, CB 14508, CB 14533, TR 0927, TR 13069 and TM 12061 the AE was increasing with increasing level of nitrogen, other genotypes showed decreasing ~~trendsequence~~ with increasing level of nitrogen levels. The genotypes viz., ASD16, ADT39, ADT45, TPS 5, AD09206, CB06803, ACK14001, TM10085, TM12007, PM12009 and EC725224 are under Efficient and responsive (ER) category which gives average yield at low level and high N use efficiency. The plant height, ~~p~~Productive tillers, total grains, harvest index, panicle length and 1000 grain weights given varied results among the genotypes due to genetic characters. Among the N levels the plant height, panicle length, productive tillers per hill and total grains showed highest in 180 kg N ha⁻¹. 1000 grain weight and N harvest index were decreased with increasing level of N application.

Keywords: Nitrogen, Rice genotypes, N harvest index, Yield attributes, N use efficiency

Introduction

Rice (*oryza sativa* L.) belongs to family “Graminae” and genus “*Oryza*”. Rice is one of the most vital crops among the cereals; it serves as the staple food for world’s half population for over 2.7 billion people (FAO, 2014). It is required that by 2025, the world will need about 800 million tonnes of rice to ~~fulfill the needs accomplish~~ for the growing population, whereas India demand to produce 120 million tonnes by 2030 to feed its one and

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Comment [w1]: present the concluding result or impact of study for futureresearch

32 half billion plus population by then. Therefore, it is requisite to overcome food scarcity
33 throughout the globe by sustainable production of rice. In India, area under rice is 44.6 m ha
34 with total output of 80 million tonnes (paddy) with an average productivity of 1855 kg ha⁻¹.
35 India is not only a leading consumer of rice but also its second largest producer in the world
36 (106.5 million tonnes), lying lagging behind only Cehina (144 million tonnes). The constraints
37 in rice production vary from state to state and area to area. Imbalanced nutrient is one among
38 the problem for low rice production.

39 Nitrogen is the most limiting macronutrient in rice production given the importance of
40 nitrogen fertilization on the yield on grain from rice plant, it is necessary to know what the
41 optimum rate for each variety/genotypes as well as its influence on components of yield and
42 yield parameters to obtain better knowledge to productive response (Noor, 2017). Since
43 fertilization is considered to be quite expensive it becomes highly essential to apply doses
44 that would prove not only appropriate but economical as well. The rice crops are inefficient at
45 nitrogen uptake from soil, with as much as 50-75% of applied N being left unused by the
46 plants (Hodge *et al.*, 2000). Therefore, excessive use of nitrogen fertilizer leads to the
47 negative impact on the soil and environment through residual effect. Hence, next to
48 fertilization of soil, selection of N use efficient crops is an important target to produce higher
49 yields with low nitrogen rates. El-Batal *et al.* (2004) recorded that nitrogen application
50 increase from 120 to 190 kg N ha⁻¹ improved plant height, panicle length, number of filled
51 grains/panicle and grain yields significantly. Similarly, Yoseftabar (2013) found significant
52 increase in plant growth parameters, yield traits and grain yield at the rate of 100, 200 and
53 300 kg N ha⁻¹. This study was conducted with the objectives to evaluate different nitrogen
54 levels on yield and yield attributes of rice genotypes in southern district of tamilnadu.

55 **Materials and Methods**

56 **Soil characteristics**

57 Soil samples for the experiment were obtained at a depth of 0-15cm from rice
58 research station, Ambasamudram, Tirunelveli. The collected sample was air-dried, crushed
59 thoroughly, sieved through a 2 mm sieve and physical and chemical characterization obtained
60 through laboratory analysis (Table 1). The soil was sandy loam in texture, acidity in reaction,
61 low in organic carbon, available nitrogen, phosphorus and potassium.

62 **Field experiment design**

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63 | Field experiment was conducted at B1 field at experimental farm of [Rice Research](#)
64 | [Station](#), Ambasamudram during 2017 rice growing season of pishanam. The 32 rice
65 | genotypes/varieties namely ASD16, ADT 39, ADT 43, ADT 45, MDU 5, CO51, TPS 5,
66 | Anna 4, AS 12051, AS12104, AD 09206, AD 10034, ACK 14001, ACK 14004, CB 08702,
67 | CB 13539, CB 14508, CB 06803, CB 14533, TR0927, TR0351, TR13069, TR13083,
68 | TM1307, TM07335, TM 09135, TM 10085, TM 12059, TM12077, PM12009 and EC
69 | 725224 were evaluated in this experiment. Nitrogen fertilizer was applied at different 4 levels
70 | (0, 50, 100 and 150% of recommended doses) as urea form. It was applied as four equal splits
71 | as split method as follows i.e., basal- the first dose of nitrogen after transplanting, the second
72 | dose was applied after 30 days of transplanting, the third dose was applied after 60 days of
73 | transplanting and the last dose was applied after 75 days of transplanting. The experiment
74 | was designed as split plot randomized design with two replications. In that, the 32 genotypes/
75 | varieties were subjected in main plots and subplots were subjected to the different nitrogen
76 | levels. The germination percentage of all the genotype seeds was 90%. The seeds were sown
77 | by line sowing method in nursery bed on 3rd October in 2017. Seedlings of 14 days old age
78 | (single seedlings per hill) was transplanted at 25 cm x 25 cm distance between hills and rows
79 | by following system of rice Intensification (SRI). Phosphorus fertilizer at the rate of 57 kg
80 | P₂O₅ / 0.24 ha was applied basally before last puddling. Intercultural operations such as
81 | irrigation and drainage, weeding and pest control were done as and when required. Plots were
82 | drained with water before 10 days of harvesting for ease of handling crop harvest. Plant
83 | height at maturity was measured from randomly selected 5 hills per plot from the soil surface
84 | to the tip of the tallest panicle of each hill. Number of filled and unfilled grains per panicle
85 | was counted of five main panicles in each plot. Panicle length (cm) from panicle base up to a
86 | piculus of the upper most spikelet of the panicle from five panicles, 1000 grain weight (g),
87 | straw and grain yield kg ha⁻¹ were estimated according to IRRI (1996). Nitrogen use
88 | efficiency was calculated according to fageria *et al.* (1997). Nitrogen harvest index is defined
89 | as the ratio between nitrogen (N) uptake in grain and N uptake in grain plus straw or shoot.
90 | Nitrogen harvest index = Nitrogen uptake in grain / Nitrogen uptake in grain and shoot.

Comment [w3]: why this 15 days interval instead of 30 days

91 **Statistical analysis**

92 | All data recorded were statistically analysed by following the procedure described by
93 | Gomez and Gomez (1984) using the AGRESS computer software at P > 0.05.

94 **Results**

95 Effect of rice genotypes

96 | Our experiment revealed that plant height of genotypes showed significantly different (Table
97 | 1). The total mean of plant height was 105.6 cm and ranged from 98.1 to 129.0 cm. The
98 | highest plant height was found in the genotypes CB06803 (V₁₅) of 129 cm which was
99 | statistically ~~at~~ par with CBN08702 (V₁₆) of 127.6 cm whereas; genotypes V₁₀ (AS12104)
100 | entered the shortest plant (94.3 cm). The ~~most likely~~probable reason might be due to genetic
101 | characters of the cultivars. Kumar *et al.* (2003) also observed the variable plant heights
102 | among the genotypes. The number of productive tillers of the rice genotypes ranged between
103 | 11.3 to 21.5 tillers per hill. The total mean productive tiller was 15.6 and the highest number
104 | recorded in TR13083 with 21.5 numbers. The lowest number of productive tillers was
105 | observed in CB14533 (11.3 per hill). Thenmozhi and rajasekaran (2014) who stated the
106 | number of productive tillers differed due to varietal variation. The result is supported by
107 | Hussain *et al.* (2008) who stated that effective tillers / hill varied with their genotype.

108
109 | The NHI is an important index to measure retranslocation efficiency of absorbed N from
110 | vegetative plant parts to grain. It ranged from 0.47 to 0.79 among the genotypes. The
111 | maximum NHI was recorded in MDU5 (0.79) and lowest was obtained from CB14508
112 | (0.47). This index is very useful in measuring N partitioning in crop plants, which provides
113 | an indication of how efficiently the plant utilized acquired N for grain production (Fageria
114 | and Baligar, 2003a). Thus, the variations in NHI are characteristic of genotypes and this trait
115 | may be useful in selecting crop genotypes for higher grain yield (Fageria and Baligar, 2005).

116 | The length of panicle was significantly affected by rice cultures. The longest panicle (28.5)
117 | was found in the genotype TR13083 which was statistically on par with ASD16. The shortest
118 | panicle length (20.2 cm) was recorded from the genotypes CB14533. The variation as
119 | assessed might be mainly due to the genetic background of the genotypes. The data showed
120 | that number of total grains per panicle was highly significantly ($p < 0.05$) affected by the main
121 | effect of genotypes. The highest number of total grains was recorded in the rice genotype
122 | ASD16 with 292 numbers per panicle which was statistically on par with TR12083 genotype
123 | with 284 grains per panicle. The lowest number of grains per panicle was recorded in CB
124 | 14533 with 87 grains per panicle. It might be due to their differences in genetic constituents.
125 | The less significant difference was found in 1000 grain weight among the genotypes due to
126 | genetic variability (Mannan *et al.*, 2010). Maximum 1000 grain weight was observed in
127 | CB08702 (28.39) followed by EC725224 (27.4 g).

128

129 **Effect of nitrogen**

130 Plant height was increased with the increasing rates of nitrogen up to 180 kg N ha⁻¹ and was
131 found significantly higher from the other levels of nitrogen (Table 2). The shortest plant
132 height (102.3 cm) was found in control plot (without N). Nitrogen included maximum
133 vegetative growth with higher rates of N. The increase in plant height was due to the various
134 physiological processes including cell division and cell elongation of the plant. Similar result
135 was found by mallareddy and padmaja, 2013 who found the tallest plant height from 180 kg
136 ha⁻¹ and the shortest was obtained from control.

137

138 Nitrogen harvest index (NHI) is defined as the ratio between nitrogen (N) uptake in grain and
139 N uptake in grain plus straw or shoot. Nitrogen harvest index ranged from 0.63 to 0.71 by the
140 application of nitrogen. The maximum value of NHI was recorded in the application at 50%
141 RD of nitrogen. NHI decreased with increasing nitrogen application. The Number of
142 productive tillers hill⁻¹ followed a pattern similar to that of plant height. Nitrogen dose of 180
143 kg N ha⁻¹ produced the highest number of tillers which was statistically on par with 120 kg N
144 ha⁻¹ respectively. The lowest number of productive tillers found from control plot. The tiller
145 numbers was increased proportionally with the increase of nitrogen levels and also found by
146 Haque *et al.*, (2004). Panicle length and total grains was higher in the N dose of 180 Kg N ha⁻¹
147 ¹. Dahi and Singh (2018) also stated that among the nitrogen levels, application of 180 kg N
148 ha⁻¹ recorded significantly higher panicle length, grains panicle⁻¹, number of panicles m²
149 which is at par with application of 150 kg N ha⁻¹. Increased yield attributes with higher
150 nitrogen application might be due to better growth characters which ultimately resulted in
151 higher production and translocation of photosynthates towards panicle.

152

153 In thousand grain weight the varieties ASD16, ADT39, ADT43, TPS5, Anna4, ACK14004,
154 AS12051,AS12104,TR13069,TM13007, TM12059,PM12009 and EC725224 increased with
155 increased nitrogen application, rest of the genotypes showed decreasing effect when nitrogen
156 increases at 120 and 180 kg N ha⁻¹. Bhuiya *et al.* (1998) also found that application of
157 nitrogen 0-60 kg N ha⁻¹ increased the thousand grain weight linearly. However the individual
158 grain weight is usually a stable varietal character and the management practice gas less effect
159 on its variation (Yoshida,1981).

160

161 **Combined effect of genotypes and Nitrogen levels**

162 There is a non significant result in plant height, thousand grain weight and productive tillers.
163 There is a significant result in grain and straw yields, total grains per panicle and panicle
164 length. In V_1N_3 (ASD16 along with 180 kg N ha^{-1}) showed highest yield, panicle length and
165 total grains per panicle. In plant height, $V_{15}N_3$ (CB06803 with 180 Kg N ha^{-1}) and in
166 thousand grain weight $V_{16}N_1$ (CB08702 with 60 kg N ha^{-1}) showed highest weight.

167 **Grain and straw yield**

168 Grain yield of rice genotypes mainly depends on the number of effective tillers per hill,
169 panicle length, total grains panicle⁻¹ and thousand grain weight. Grain and straw yields
170 increased in a linear model with the addition of nitrogen at different levels from 60 to 180 kg
171 ha^{-1} (Table 1). Grain yield varied from 1543 kg ha^{-1} at control (CB14533) to 8150 kg ha^{-1} at
172 150% N (ASD 16) with an average value of 5155 kg ha^{-1} . Among four N levels of 0, 60, 120
173 and 180 kg ha^{-1} , the highest grain and straw yields were recorded at N_3 (180 kg ha^{-1}) by the
174 most of the rice cultures, except the AS 12051, ACK 14004, CB08702, CB 13539 and PM
175 12009 which were not responded genotypes for higher dose of (180 kg ha^{-1}) nitrogen. Among
176 the released varieties, ASD 16 recorded highest mean yield of 6698 kg ha^{-1} followed by
177 MDU5 (6014 kg ha^{-1}), ADT 45 (5875 kg ha^{-1}) recorded and were responded to higher dose of
178 N applied. In cultivars, the highest mean yield was observed in ASD 16 (6698 kg ha^{-1}), TR
179 13083 (6695 kg ha^{-1}) followed by TM 12077 (6162 kg ha^{-1}). The percent increase of grain
180 yield was maximum (57.55%) in CB 14533 though it gives lowest yield among all the
181 genotypes. The straw yield varied from 3011 kg ha^{-1} (CB14533) to 10292 kg ha^{-1} (ASD16)
182 with an average of 7505 kg ha^{-1} . As that of grain yield, the same trend was followed on straw
183 yield also. The overall highest mean yield was recorded by TR13083 (9388 kg ha^{-1}) which
184 was on par with ASD 16 (8884 kg ha^{-1}). The lowest yield of 4798 kg ha^{-1} was recorded in the
185 cultivar CB 14533 but the percentage increase in both grain and straw yields by computed to
186 control by highest level of N was more in this cultivar CB14533 which indicate the response
187 level was high in cultivar.

188 **Nitrogen use efficiency**

189 NUE is a product of nutrient recovery from mineral or organic fertilizer and the efficiency
190 (ARE) with which the plant uses each additional unit of nutrient (PE). It depends on cultural
191 practices that influence recovery and physiological efficiency. NUE was significantly

192 affected by nitrogen application and increased with N levels and also decrease with
193 increasing N levels in different rice genotypes (table 2). Among the genotypes, TM 12077
194 had the highest nitrogen use efficiency of 22.73 kg kg N⁻¹ followed by TM 10085 (20.51 kg
195 kg N⁻¹). Across the N levels, the agronomic efficiency decrease with increasing N levels of
196 nitrogen from 13.41 kg kg N⁻¹ at 50% RD of N to 10.90 kg kg N⁻¹ at 150% RD of N. In the
197 interaction of Genotype and N levels, the highest NUE was recorded in PM12009 at the rate
198 of 50% RD of N (60 kg ha⁻¹). The lowest NUE was recorded in genotypes, N levels and
199 interaction, Anna 4 recorded the lowest AE. In the genotypes ASD 16, ADT 43, ADT 45,
200 CO 51, MDU 5, CB 14508, CB 14533, TR 0927, TR 13069 and TM 12061 the NUE was
201 increasing with increasing level of nitrogen, other genotypes showed decreasing sequence
202 with increasing level of nitrogen levels. Such variations may be occurred because of genetic
203 factors, biochemical and physiological processes such as translocation, assimilation and N
204 remobilization (Isfan 1993; Fageria and Baligar 2003).

205 Overall, the results of this experiment identified that the application of higher doses of
206 nitrogen increased the grain yield up to 150% recommended doses of nitrogen ha⁻¹, but in
207 some of the genotypes viz., AS12051, ACK14004, CB08702 and PM12009 were not given
208 any response to higher doses of N application (150% RD of N ha⁻¹). The NUE parameters
209 varied significantly among rice genotypes. The choosing of rice genotypes and optimum N
210 application rate for different rice genotypes is not only for producing higher yield, but also
211 for improving soil fertility and economic net return for farmers.

Comment [w4]: advisable to include conclusion with outstanding results summary

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Comment [w5]: I could not see the table with effect of nitrogen on different rice varieties

259

260 **Table 1: Differences in yield parameters of 32 rice genotypes**

	Plant height (cm)	No. of total grains hill ⁻¹	N Harvest Index	No. of productive tillers hill ⁻¹	Panicle length (cm)	1000 grain weight (g)
Genotype						
V ₁	108.2	292	0.70	19.8	27.8	27.4
V ₂	96.3	186	0.73	15.5	23.7	19.5
V ₃	106.9	177	0.70	15.5	23.5	19.2
V ₄	104.7	219	0.75	16.5	24.9	24.1
V ₅	103.5	193	0.67	15.5	23.8	19.6
V ₆	98.4	167	0.55	14.8	23.1	18.6
V ₇	102.0	258	0.79	17.8	26.4	25.9
V ₈	106.6	201	0.61	16.3	24.1	21.1
V ₉	100.0	142	0.72	13.8	21.7	17.1
V ₁₀	94.3	213	0.72	16.5	24.8	23.5
V ₁₁	102.1	146	0.57	14.3	22.4	17.3
V ₁₂	101.8	174	0.70	15.5	23.4	19.0
V ₁₃	110.6	264	0.68	18.3	26.2	26.0
V ₁₄	98.1	199	0.63	15.8	23.9	19.9
V ₁₅	129.0	170	0.67	15.3	23.2	18.9
V ₁₆	127.6	159	0.74	14.5	22.8	18.1
V ₁₇	106.2	118	0.47	12.3	20.5	15.8
V ₁₈	104.7	208	0.63	16.5	24.5	22.9
V ₁₉	94.9	87	0.51	11.3	20.2	15.1
V ₂₀	95.3	121	0.51	12.8	21.2	16.4
V ₂₁	115.8	240	0.69	17.3	25.3	24.9
V ₂₂	105.8	152	0.62	14.3	22.8	17.5
V ₂₃	103.7	284	0.69	21.5	28.5	19.4
V ₂₄	101.9	246	0.66	17.3	25.5	25.7
V ₂₅	98.2	224	0.69	16.8	25.1	24.4
V ₂₆	115.4	147	0.69	14.3	22.8	17.4
V ₂₇	102.7	205	0.68	16.3	24.3	21.6

V ₂₈	108.3	154	0.74	14.3	22.8	17.9
V ₂₉	107.3	132	0.59	13.3	21.4	16.7
V ₃₀	109.0	273	0.62	18.5	26.8	26.6
V ₃₁	112.6	162	0.61	14.5	23.0	18.2
V ₃₂	106.7	136	0.58	13.5	21.8	16.9
CD (P=0.05)	2.82	11.75	0.03	1.74	0.65	0.05

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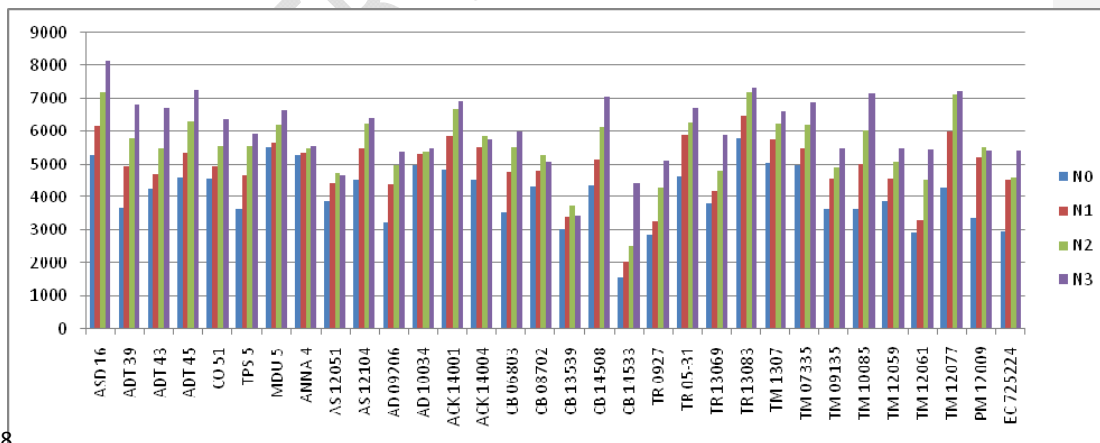
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265 **Table 2: Effect of nitrogen on different yield parameters of 32 rice genotypes**

	Plant height (cm)	No. of total grains hill ⁻¹	N Harvest index	No. of productive tillers hill ⁻¹	Panicle length (cm)	1000 grain weight (g)
N levels						
N ₀	102.3	171	0.70	14.2	22.9	19.7
N ₁	104.9	188	0.65	15.2	23.7	20.3
N ₂	106.6	196	0.64	16.2	24.2	20.6
N ₃	108.5	201	0.63	16.8	24.4	20.9
CD (P=0.05)	1.11	3.47	0.009	0.61	0.21	0.02

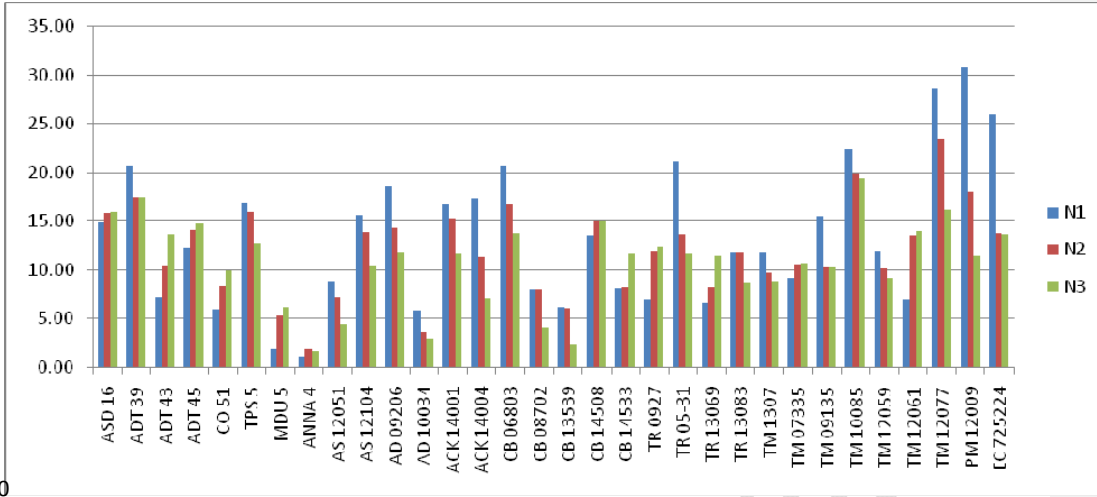
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267 **Fig 1: Effect of different N application on grain yield of 32 rice genotypes**



268

269 **Fig 2: Effect of different N application on NUE of 32 rice genotypes**



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