

TKM 15 -A High yielding, short duration rice variety suitable for direct sown water limited areas of Tamil Nadu

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ABSTRACT

Comment [UN1]: This section lacks the brief explanation of characteristics feature related to the recommended variety.

Many references are missing since the material method section lacks many explanations related to the findings of the current problem.

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TKM 15 is a short duration, drought tolerant rice variety released from Rice Research Station, Tirur (TNAU) for direct sown rainfed and semidry areas of Tamil Nadu viz., Kancheepuram, Chengalpattu, Tiruvallur, Pudukottai, Ramanathapuram, Virudhunagar, Sivagangai and Thoothukudi districts. It matures in 118 days and has the ability to withstand early-stage water stress, good germination percentage under direct sowing, early vigour and high drought recovery. This variety has manifested the grain yield of 3995 kg/ha and 4217 kg/ha under rainfed and semidry conditions respectively which was 10.42% per cent and 17.89 per cent increase over the check variety Anna (R) 4 in rainfed and semidry conditions. TKM 15 has erect, high tillering and non-lodging plant habit, with dense droopy compact panicle (25 cm) having ~~more~~ greater number of grains per panicle (253 no.). It is moderately resistant to major diseases such as blast, sheath rot, sheath blight, brown spot and RTD and field tolerant to major pests like leaf folder, stem borer and gall midge which are its added advantage. It has good hulling (80%) percentage, milling (68%) percentage and Head Rice Recovery of 62.9 %. Rice is white, medium slender with 1000 grain weight of 15.0 g with non-sticky property and has good taste upon cooking. ~~Cooked rice is non-sticky with good taste.~~ The feedback from the farmers was that, TKM 15 tolerates water stress and recovers quickly with the receipt of rainfall, has more tillers, densely packed panicle with medium slender grains, gives higher yield under rainfed and semidry environments and also free from pests and diseases under field condition.

KEY WORDS: TKM 15, Rice, Rainfed, Semidry, direct sowing, drought tolerant.

INTRODUCTION

Comment [UN3]: Follow the prescribed template for citation in the journal authors guideline section (sample template).

Rice is the staple food for more than one-third of the world's population [Sahebi *et al.*, 2018] and to achieve self-sufficiency in rice production, high yielding rice variety with a high degree of resistance to both biotic and abiotic stresses is a prerequisite [Chukwu *et al.*, 2019].

In Tamil Nadu, Rice plays a vital role in ensuring food security and is cultivated in an area of 20.36 lakh hectares in which, about 36 % of the paddy area is cultivated in the delta districts such as Tiruvarur (1.95 lakh ha), Thanjavur (2.14 lakh ha), Nagapattinam (0.74 lakh ha), Mayiladuthurai (1.06) and Cuddalore (1.36 lakh ha). Tiruvannamalai (1.71 lakh ha) has the next highest area followed by Ramanathapuram 1.34 lakh ha, Villupuram (1.02 lakh ha), Thiruvallur (1.01 lakh ha), Pudukottai (0.92 lakh ha) and Sivagangai (0.78 lakh ha) and these districts are characterised more by dryland agriculture (Sesasons and Crops Report, 2021). Around 45 per cent of the total cultivable area in Tamil Nadu (13

36 per cent of the total rice grown area) is rainfed which is prone to frequent droughts that are triggered by
37 monsoon failures and has affected water storage in all the water bodies.

38 Drought is one of the major abiotic stresses that affect rice production in rainfed areas. Recent
39 trends in climate change will further increase the intensity and frequency of drought in the coming
40 years. Current global warming trends are expected to lead to a greater intensity, frequency and severity of
41 droughts (Diffenbaugh *et al.*, 2015, Prudhomme *et al.*, 2014). Any detrimental impacts of climate would
42 have major consequences for food security from local to global levels. Drought scenario of Tamil Nadu for
43 the last 10 years reveals that Tamil Nadu experienced recurrent droughts during the years
44 2012, 2013, 2014, 2016 and 2018 and the state has been reeling under drought for three consecutive years
45 2012, 2013 and 2014. In 2016, worst drought hit in 140 years, was considered as a disaster by the
46 farmers of Tamil Nadu and the state had been declared drought-hit. In 2018, about 24 of 32 districts
47 were affected by hydrological drought of which 19 districts have reported a fall in groundwater levels. The
48 consecutive failure of the North East monsoon resulted in a water crisis in Tamil Nadu.

49 Ramnad, Sivagangai and Thiruvallur districts form 51.58, 11.50 and 10.09 percent respectively of
50 the total rainfed and semidry rice areas in the state of Tamil Nadu. Apart from these districts, direct
51 seeded rice is being practised in districts like Kancheepuram, Villupuram, Thoothukudi, Pudukottai and
52 Virudhunagar. Farmers in these areas cultivate either land races or high yielding varieties bred for
53 irrigated environment. Land races were not providing any significant yield gains to the farmers and
54 farmers realized heavy yield loss while cultivating high yielding varieties bred for irrigated environment
55 during drought years. When high yielding irrigated varieties are grown in rainfed ecosystem, significant
56 loss in rice production is recorded during the frequent drought spell because the aforesaid high- yielding
57 varieties succumb to frequent droughts (Hao *et al.*, 2018).

58 Due to narrow choice of rice varieties for drought prone environment, farmers face difficulty in
59 increasing rice production in these areas. High yielding rice varieties endowed with virtues and values of
60 drought tolerance and with stable yield performance is the need of the hour. Hence, evolving drought
61 tolerant varieties which can withstand drought with minimal yield loss is crucial. Farmers are in urgent
62 need of direct seeded rice varieties suitable for rainfed and semidry cultivation with high yield potential
63 and preferable grain quality similar to the fine grain irrigated rice varieties. Therefore, attempts were
64 made to develop a short duration, high yielding drought tolerant rice variety suitable for rainfed and
65 semidry cultivation. As a result, drought tolerant, short duration, high yielding rice variety with medium
66 slender grain evolved at Rice Research Station, Tirur was released as TKM 15 during 2022 by State
67 Variety Release Committee of Tamil Nadu and notified by the Central Ministry of Agriculture and Farmers
68 welfare during August, 2022.

69 **MATERIALS AND METHODS**

70
71
72 Hybridization was made between TKM (R) 12 and IET 21620 during *Somavari*, 2010 at Rice
73 Research Station, Tirur with an objective of evolving short duration, drought tolerant rice variety suitable
74 for rainfed and semidry cultivation with medium slender grain type. Breeding method followed is

Comment [UN4]: This section needs to be more rigorous and must include all the methodologies related to the findings obtained in this current study.

For example, this section lacks the following attributes:
Disease scoring criteria
Quantitative estimation procedures followed for amylose, proline, chlorophyll

The details of PEG treatments, chlorophyll stability index and molecular markers are missing in this section

75 hybridization and selection and homozygous line was fixed as TM 12077 in F₅ generation during *Samba*,
76 2012. The detailed breeding programme is depicted in Fig 1. Performance of TM 12077 was tested in
77 different yield trials at Rice Research Station, Tirur during 2013 to 2015 under rainfed and semidry
78 conditions and in Multi Location Trials under different environmental conditions such as dry, semidry and
79 aerobic conditions for two years during 2016 to 2018 in ten locations. Based on the performance, this
80 culture was promoted to Adaptive Research Trials and was tested in seven districts of Tamil Nadu viz.,
81 Tiruvallur, Kancheepuram, Villupuram, Viruthunagar, Thoothukudi, Sivakangai, and Ramnadapuram and
82 five KrishiVigyanKendras viz., Tiruvallur, Aruppukottai, Tindivanam, Sivagangai and Ramanathapuram
83 during 2018-19 and 2019-20. Performance was also assessed in ~~thirty-two~~ ^{thirty-two} farmer's holdings as
84 On Farm Trials (OFT) during 2019 to 2021 and in five Large Scale Demonstrations in 2021-22. TM
85 12077 was also evaluated in All India Coordinated Rice Improvement Programme (AICRIP) trials during
86 *khari*, 2017 under Initial Varietal Trial (IVT)- Early Direct Sowing. Physical, cooking and biochemical
87 quality parameters were analysed at Tamil Nadu Rice Research Institute, Aduthurai. Reaction to pests
88 and diseases was studied at Coimbatore, Aduthurai, Madurai and Thirupathisaram. Laboratory studies
89 on drought tolerance in seedling stage as well as physiological parameters were done at Agricultural
90 College and Research Institute, Echankottai.

91

92 RESULTS AND DISCUSSION

93

94 To achieve self-sufficiency in rice production, rice varieties having high yield along with high
95 degree of resistance to both biotic and abiotic stresses is a prerequisite (Chukwuet al, 2019). Drought is
96 one of the major abiotic stresses that affect rice production in rainfed areas. Recent trends in climate
97 change will further increase the intensity and frequency of drought. The increase in drought severity and
98 lack of drought tolerant high-yielding varieties for rainfed environment are the important factors
99 responsible for low production of rice in rainfed ecosystem. Breeding rice varieties with tolerance to
100 drought stress offers an economically viable and sustainable option to improve rice productivity (Pandey
101 and Shukla, 2015). Farmers of drought prone areas require varieties that provide higher yield in years of
102 good rainfall and sustainable good yield in years with drought. The development of improved varieties
103 with combined tolerance of drought stress at multiple growth stages will help farmers in rainfed rice
104 growing regions and maintain stable yields across increasingly unpredictable climatic conditions (Padmini
105 et al., 2017).

106 TM 12077, a derivative of TKM (R) 12 / IET 21620 is a short duration rice culture (118 days)
107 having erect, high tillering and non-lodging plant habit. This culture was specially bred for direct
108 sowing environments under rainfed and semidry situations. In station trials conducted at Rice Research
109 Station, Tirur, it recorded a mean grain yield of 3718 kg/ha under rainfed and 4418 kg / ha under semidry
110 conditions which is 15.22 % and 18.19 % higher than the check variety Anna (R) 4 under rainfed (3227
111 kg/ha) and semidry conditions (3738 kg/ha) respectively. In Multi Location Trials conducted in 10
112 locations during 2016 to 2018, TM 12077 registered 2777 kg/ha under rainfed and 2930 kg/ha under
113 semidry conditions and the yield increase recorded was 31.9 and 22.5 per cent over Anna (R) 4

114 respectively in rain fed (2105 kg/ha) and semidry (2392 kg/ha) conditions. This culture was also
115 nominated to All India Co-ordinated Rice Improvement Project (AICRIP) Trials and tested in Initial Varietal
116 Trial-Early Direct Sowing (IVT-EDS) as IET 26645 during *Kharif*, 2017 and recorded the yield of 3386 kg
117 /ha in 115 days. Adaptive Research Trials were conducted in 62 locations covering seven districts viz.,
118 Tiruvallur, Kancheepuram, Villupuram, Ramnad, Sivagangai, Viruthunagar and Thoothukudi during 2018-
119 2020 and a mean grain yield of 4421 kg/ha was recorded by TM 12077 which was 4.76 % higher than the
120 check variety Anna (R) 4 (4220 kg/ha) (Table 1).

121 The technologies or varieties developed by the researchers should reach the target end-users.
122 On farm trials are conducted to showcase the advantages of new varieties to farmers which will help in
123 convincing more farmers to make better choice of varieties. The culture TM 12077 was tested in
124 farmer's holdings, in order to evaluate the performance of this culture in On Farm Trials and Large Scale
125 Demonstrations under existing farming situations and to get feedback from farmers and field
126 functionaries. The performance of TM 12077 was assessed in On Farm Trials in 32 farmers' holdings
127 during 2019, 2020 and 2021 over the check variety Anna (R) 4 in Tiruvallur, Sivagangai and
128 Ramnad districts and a yield of 4420 kg/ha and 4920 kg/ha under rainfed and semidry respectively was
129 manifested by the test entry whereas Anna (R) 4 recorded the grain yield of 4230 kg/ha and 4250 kg/ha
130 under rainfed and semidry conditions respectively. In the On Farm Trials conducted during 2020-21 along
131 with the newly released drought tolerant rice variety CO 53, grain yield recorded by TM 12077 and CO 53
132 was 4213 kg/ha and 3972 kg/ha respectively under rainfed and 4601 kg/ha and 4197 kg/ha respectively
133 under semidry condition. The yield advantage of 6.07% under rainfed and 9.6 % under semidry
134 environments over CO 53 was realized (Table 2).

135 Large scale demonstrations of TM 12077 conducted at Tiruvallur and Paramakudi districts
136 showed that a grain yield of 4409 kg in 117 days which was 8.1% increase over CO 53 (4078 kg /
137 ha) (Fig. 2). The farmers in rainfed regions preferred this culture because it tolerates water stress and
138 recovers quickly with the receipt of rainfall. The farmers were convinced with the high tillering ability,
139 compact panicles, more number of grains per panicle, medium slender grain type, non-lodging and field
140 tolerance to major pests and diseases of this culture.

141 The overall mean performance of TM 12077 against the check variety viz., Anna (R) 4 in different
142 yield trials was 3995 kg/ha and 4217 kg/ha at rainfed and semidry condition respectively which was 10.42
143 per cent and 17.89 per cent higher than Anna (R) 4 (Table 1).

144 The culture TM 12077 was screened against all the epidemic diseases such as blast, sheath rot,
145 sheath blight, brown spot and rice tungro disease (RTD) during 2016, 2017, 2018 and 2019 under field
146 screening and it was found to be moderately resistant to blast, sheath rot, sheath blight, brown spot and
147 rice tungro disease (RTD) (Table 3). It was also evaluated for major pests at Coimbatore, Aduthurai and
148 Madurai during 2016 to 2019 and TM 12077 has resistance to stem borer, leaf folder and gall midge
149 (Score 1) under field condition (Table 4).

Comment [UN5]: Incorporate the tables and figures immediately after citing them inside the text rather than putting them altogether at the end of the MS. Follow the articles in the archive section in the journal homepage for clarity.

150 In rice, grain quality is as important as yield. Consumer preference and market price have been
151 determined by rice grain quality which involves milling quality, physical appearance and cooking
152 quality. TKM 15 variety has medium slender grain type with the kernel length of 5.6mm and L/B ratio of
153 3.11. It has good hulling (80.0 %), milling (68.0 %) and Head rice recovery (62.9%). Amylose content,
154 gelatinization temperature and gel consistency are considered to be three indicators for cooking and
155 eating quality in rice. TKM 15 has intermediate amylose content (21.60), soft gel consistency and high to
156 intermediate gelatinization temperature. Upon cooking, linear elongation ratio of 1.60 and volume
157 expansion of 4.0 ml was recorded (Table 5).

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159 Studies on drought tolerance

160
161 Unlike some other crops, rice is extremely sensitive to drought conditions during the germination
162 and early seedling growth stage. Drought stress causes trouble of water balance, and damages metabolic
163 process at cell level viz., impairment of membrane transport, and decreases ATP production and
164 respiration, leading to poor seed germination (Kadam *et al.*, 2017).

165 Vigorous plant growth at the seedling stage under stress condition has been used as a criterion
166 for selecting the tolerant individuals. Laboratory studies (Table 6) were performed to assess the drought
167 tolerance potential of genotypes through changes in germination, shoot and root length of the seedlings
168 under Poly ethylene Glycol (PEG) induced drought stress. Stimulated drought conditions had been
169 achieved *in vitro* through incorporation of osmotic solutes such as PEG in the media which was utilized by
170 several authors to screen various genotypes for drought tolerance (Kacem *et al.*, 2017, Hellal *et al.*,
171 2018). In the present study, there was a considerable decrease in the germination potential among all the
172 genotypes with increase in PEG concentration from 0.2MPa to 1.0 MPa. TM 12077 showed higher level
173 of tolerance to PEG induced drought stress showing 28.4% germination with 2.5cm and 8.23cm shoot
174 and root length respectively at 1.0MPa when compared to Anna (R) 4 which was found to be moderate in
175 drought tolerance with 14.8% germination at the same level of PEG concentration. TKM 12 showed poor
176 ability to cope up with tolerance reaction to drought even at 0.6MPa and showed considerable reduction
177 in germination (21.4%) and also shoot (2.3cm) and root length (5.0cm) when compared to Anna (R) 4 and
178 TM 12077. Among the four genotypes that were subjected to drought under field condition and analysed
179 for proline content (mg/g) at 60 % field capacity, TM 12077 showed higher accumulation of proline (2.15
180 mg/g) followed by CO 53 (1.98 mg/g), Anna (R) 4 (1.78 mg/g) and TKM 12 (1.52 mg/g). Higher
181 accumulation of proline is usually associated with drought tolerance and it helps for maintenance of leaf
182 turgor and progress in stomatal conductance (Kumar *et al.*, 2016). Hence TM 12077 can be considered to
183 have higher drought tolerance potential compared to other prominent drought tolerant rice varieties.
184 Chlorophyll Stability Index (80.23%) and total chlorophyll content (1.50 mg/g) were also found to be
185 higher in TM 12077 indicating its higher potential to withstand adverse situation like drought induced
186 stress.

Comment [UN6]:

This part of the experimental explanation is unclear related to the treatments of PEG-induced stress which should have included the concentration of the PEG applied for stress induction at subsequent levels to promote accumulation of proline (as mentioned in the table 6)

187 Root characteristics of the plants are the vital attributes for enhancing production under drought
188 stress. Generally, rice varieties with profound and prolific root system show better adaptability in drought

189 (Mishra *et al.*, 2019). Root characters are primary traits of drought tolerance and show the inherent
190 potential of genotypes to withstand drought, varieties bred for dry / semi conditions should possess better
191 root architecture than lowland varieties. Root length (cm) and root volume (cc) were also found to be
192 higher in TM 12077 (17.8 cm and 59 cc respectively) among the four genotypes under managed stress
193 condition. CO 53 showed root length of 15.4 cm and root volume of 47 cc and stood next to TM 12077
194 with respect to root characters and drought tolerance. Drought resistant entries had recorded higher root
195 thickness, root volume and deep root system than the susceptible genotypes (Pushpam *et al.*,2018). This
196 is also in accordance to the findings of Yogameenakshi *etal.* (2003) andSheeba *et al.* (2010).

197 The rice variety TKM 15 was differentiated from parents and other popular varieties *viz.*, Anna (R)
198 4 and CO 53 using the molecular marker technology. A total of 10 SSR markers were taken for the study.
199 Among these markers, RM252 and RM 442 had polymorphism between TKM 15 and popular varieties
200 and parental lines (Fig. 3).

201 Based on the superior performance of the drought tolerant rice culture, TM 12077 over the check
202 varieties Anna (R) 4 and CO 53, this culture was recommended by Tamil Nadu Agricultural University for
203 State Variety Release Committee and was released as rice variety TKM 15, a variety suitable for direct
204 sowing under rainfed and semidry environments of Tamil Nadu by SVRC during 2022 and notified by the
205 Central Ministry of Agriculture and Farmers welfare during August, 2022.

206 CONCLUSION

207 Direct seeded rainfed rice is being cultivated in the districts of Tiruvallur, Kancheepuram,
208 Ramnad, Sivagangai, Villupuram, Virudhunagar and Thoothukudi and maintained as dry or semidry crop
209 depending upon the rainfall received. Already released drought tolerant rice varieties *viz.*, Anna (R) 4
210 released during 2009 by TNAU has difficulty in milling due to long slender grain type. Rice variety CO 53
211 released during 2019 is having short bold grain mainly suitable for idly making. Farmers are in urgent
212 need of direct seeded rice varieties suitable for rainfed and semidry cultivation with high yield potential
213 and preferable medium slender grain quality and the variety TKM 15 meets the above requirement of
214 farmers in rainfed environments.

215 Since the majority of the farmers living in drought prone ecologies are socio-economically under
216 privileged, the drought tolerant variety TKM 15, can serve as one of the most viable and deliverable
217 technologies for eradicating poverty from these ecologies.

218 [Mention these following headings:](#)

219 [ACKNOWLEDGEMENTS](#)

221 [COMPETING INTERESTS](#)

223 [AUTHORS' CONTRIBUTIONS](#)

225 [REFERENCES](#)

Comment [UN7]: The parameters that make TKM 15 the most suitable one for field level recommendation must be mentioned clearly in the discussion section with a comparison to the other varieties taken under the current study.

Comment [UN8]: Follow the standard citation format provided as template in the authors' guideline section of the journal homepage. Make all the reference uniform across the MS.

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272 **Table 1. Overall Mean performance of TM 12077 over the check Anna (R) 4**

Comment [UN9]: Since this table is representative of a large population it is imperative to mention the values as Mean ± SD

Name of the Trial	No. of Locations	Grain yield (kg/ha)				% increase over Anna (R) 4	
		Dry		Semidry		Dry	Semidry
		TM 12077	Anna (R) 4	TM 12077	Anna (R) 4		
Station trial (2013- 2015)	6	3718 (117)	3227 (115)	4418 (117)	3738 (110)	15.22	18.19

MLT (2016-2018)	10	2777 (120)	2105 (108)	2930 (122)	2392 (107)	31.92	22.49
ART- DoA& KVK (2018-20)	62	4421 (117)	4220 (115)	-	-	4.76	-
AICRIP – IVT* (2017)	8	3386 (115)	-	-	-	-	-
OFT (2019-20)	5	4420 (117)	4230 (116)	4920 (116)	4250 (115)	4.49	15.76
OFT(2020-21)	25	4213 (118)	3706 (113)	4601(117)	3931(113)	13.68	17.04
Overall Mean	116	3995 (118)	3618 (113)	4217 (120)	3577 (109)	10.42	17.89

273 *Values in parenthesis denotes the duration

274
275 **Table 2. On Farm Trials conducted during 2020-21 with the recently released drought tolerant rice**
276 **variety Co 53**
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Name of the culture	No. of Trials	Grain yield (kg/ha)		Remarks
		Dry	Semidry	
TM 12077	25	4213 (118)	4601 (117)	<ul style="list-style-type: none"> Matures in 118 days Good germination and early vigour Tolerates early-stage stress and recovers quickly on the receipt of rain water. Non lodging, dense panicle, fine grain type Resistant to pest and diseases
CO 53	25	3972 (115)	4197 (110)	<ul style="list-style-type: none"> Tall plant type prone to lodging Bold grain type Tolerates drought
% increase	-	6.07	9.63	

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279 **Table 3. Reaction to major diseases of rice**
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Sl. No.	Culture	Blast			Sheath rot				Sheath blight		
		2016-17	2017-18	2019-20	2016-17	2017-18	2018-19	2019-20	2016-17	2017-18	2019-20 ADT*
1.	TM 12077	3	1	5	5	5	3	3	5	3	5
2.	Anna (R) 4	5	1	3	5	5	7	3	5	5	7
Sl. No.	Culture	BLB*		Brown spot			RTD				
		2018-19 ADT	2019-20 ADT	2016-17 CBE	2017-18 CBE	2018-19 ADT	2016-17 CBE	2017-18 CBE	2019-20 CBE		
1.	TM 12077	7	7	3	5	5	5	5	5	4	

Comment [UN10]: The explanation for the numerical values presented in the table is unclear. Mention the details of this numerical values as footnotes.

2.	Anna (R) 4	9	7	5	5	7	7	3	4
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Table 4. Reaction to major pests

Sl. No.	Culture	Stem Borer			Leaf folder				
		2016-17	2017-18	2018-19	2019-20	2016-17	2017-18	2018-19	2019-20
1.	TM 12077	1	0	1	1	1	3	1	1
2.	Anna (R) 4	1	0	3	1	1	1	1	0
Sl. No.	Culture	Gall Midge			BPH*		WBPH*	GLH*	
		2018-19			CBE (2017-18)				
		ADT	MDU						
1.	TM 12077	1	1		7		9	7	
2.	Anna (R) 4	1	0		5		9	9	

Comment [UN11]: The explanation for the numerical values presented in the table is unclear. Mention the details of this numerical values as footnotes.

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Table 5. Quality characteristics of TM 12077

i. Physical quality characteristics							
Variety	Hulling (%)	Milling (%)	Head rice recovery (%)	Kernel length (mm)	Kernel breadth (mm)	L/B ratio	*Grain Type
TM 12077	80.0	68.0	62.9	5.6	1.9	2.95	MS
Anna(R) 4	78.7	66.2	59.0	6.8	2.1	3.11	LS
CO 53	78.8	69.6	59.6	5.4	2.5	2.20	SB
ii. Cooking quality parameters							
Parameters		TM 12077	Anna (R) 4	CO 53			
Kernel length after cooking (mm)		9.0	9.2	8.5			
Kernel breadth after cooking (mm)		2.7	2.7	3.4			
Linear elongation ratio		1.60	1.60	1.59			
Breadthwise elongation ratio		1.30	1.40	1.45			
Volume expansion ratio		4.0	4.2	3.9			
iii. Biochemical characteristics							
Parameters		TM 12077	Anna (R) 4	CO 53			
Gel consistency		Soft	Soft	Soft			
Gelatinization temperature		High to intermediate	High to intermediate	High to intermediate			
Amylose content		21.7	22.6	23.50			

Comment [UN12]: Add a column below to this part mentioning the kernel length of milled rice

Comment [UN13]: Gelatinization temperature can be mentioned in this table for better representation.

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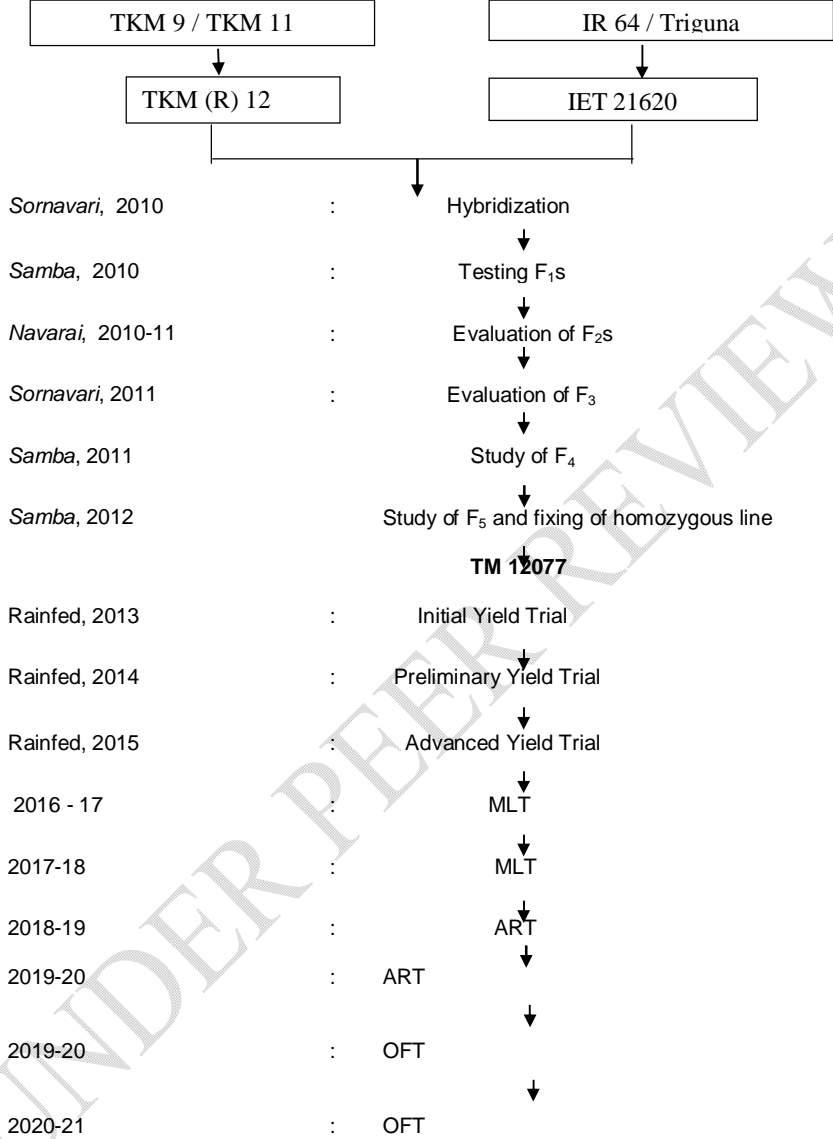
Table 6. Laboratory studies on drought tolerance under varied PEG levels

Genotypes	Control	0.2 MPa	0.4 MPa	0.6 MPa	1.0 MPa
Germination percentage (%)					
TM 12077	100.0	88.4	84.9	55.4	28.4
TKM (R)12	98.0	80.5	71.4	21.4	0.0
Anna (R) 4	97.0	84.6	79.4	38.9	14.8
Shoot length (cm)					
TM 12077	12.8	10.0	8.0	6.7	2.5
TKM (R)12	11.4	8.5	5.5	2.3	0.0
Anna (R) 4	11.2	10.1	6.7	4.2	1.9
Root length (cm)					
TM 12077	20.45	17.45	15.73	11.00	8.23
TKM (R)12	12.40	10.95	9.85	5.00	0.00
Anna (R) 4	19.75	17.80	16.25	11.80	8.25
Seedling vigour index					
TM 12077	845.20	320.62	134.78	56.33	2.01
TKM (R)12	658.30	165.90	60.34	16.90	0.26
Anna (R) 4	785.20	190.45	68.22	18.90	0.81
Physiological parameters at water stress (60% FC)					
S.No.	Genotypes	TM 12077	Anna (R) 4	TKM (R) 12	
1.	Proline content (mg/g)	4.15	3.78	3.52	
2.	Chlorophyll Stability index (%)	80.23	70.45	67.89	
3.	Total chlorophyll content (mg/g)	1.50	1.29	1.21	
Biometrical Characters under Managed stress condition					
Genotypes	Days to Maturity	Plant Height (cm)	Tillers per plant	No. of panicles / sqm	Root Length (cm)
TM 12077	117	90.0	14	302	17.8
Anna (R) 4	110	114.4	10	227	12.5
TKM (R) 12	123	115.0	10	226	13.2

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Fig.1: Pedigree of TM 12077 (IET 26645)



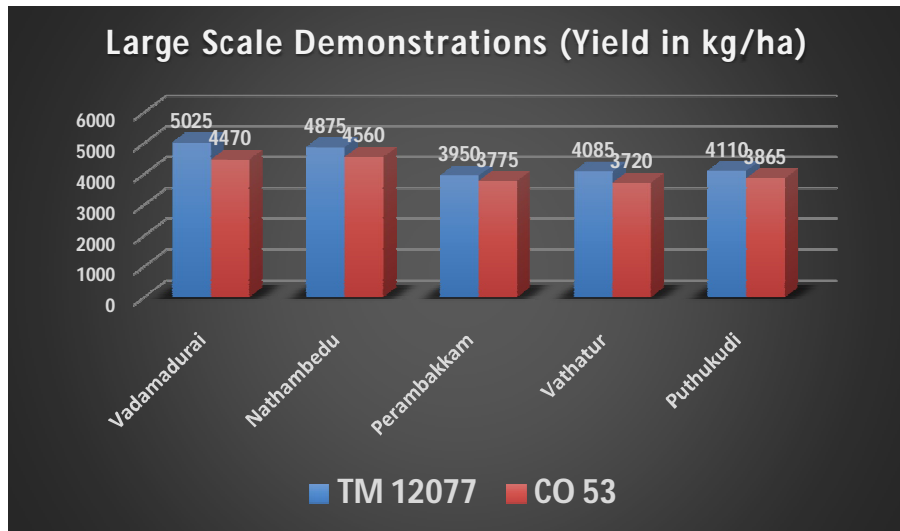
Comment [UN14]: The details of the figures should be provided below the figure instead at the top.

Figure 1 is nowhere cited inside the text!

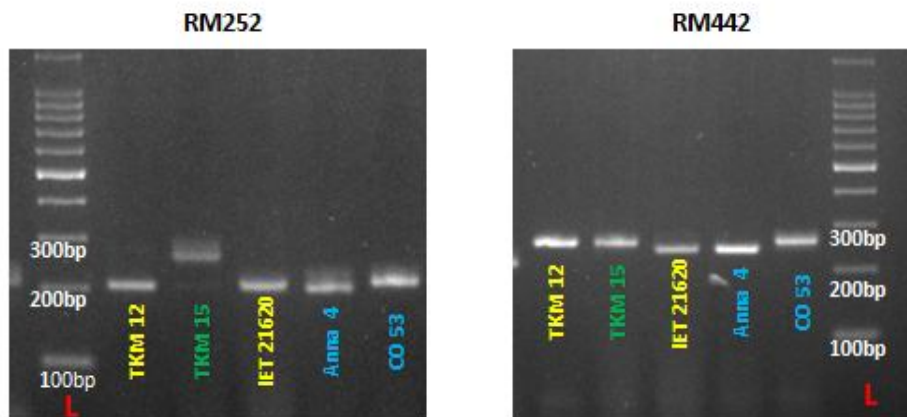
Moreover, this figure can be better represented in the form if a table since it depicts series of events over the years.

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319 Fig 2. Large Scale Demonstrations of TM 12077
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324 | Fig 3. Molecular marker polymorphism studies using mMicrosatellite markers
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