**Development and release of Trombay Jodhpur Mustard 2 (TJM 2): A promising Indian mustard variety Notified for Rajasthan, India**

**ABSTRACT**

Trombay Jodhpur Mustard 2 (TJM 2) has been notified by Central Variety Release Committee (CVRC) for cultivation in the state of Rajasthan [S.O. No. 4388 (E) 8th October, 2024]. TJM 2 recorded 14.20% and 14.63% higher seed yield over the zonal check Bio 902 and national check Kranti, respectively, in multi-location yield trials, and also exhibited a significant yield advantage of 10.24% over Kranti and 9.53% over the zonal check RGN 229 at Sriganganagar under All India Coordinated Trials (Zone II) during 2015–16. TJM 2 is resistant to aphids, moderately resistant to White Rust and highly resistant to Powdery mildew under field conditions. The variety has moderate density of siliqua on main shoot, bold seed size with 5.37 g 1000 seed weight and 39.2% oil content. In field demonstrations conducted during *Rabi* 2019-20, 2020-21 and 2021-22, TJM 2 attained 14.32 percent higher seed yield over the varieties under farmers practice. Molecular marker analysis depicted distinct SSR alleles for TJM 2 compared to Kranti, Bio 902 and Giriraj.

Keywords: *Variety, Mustard, Rajasthan, Released, Resistant*

1. **INTRODUCTION**

Edible oil demand of India is increasing day-by-day. Therefore, increasing production and productivity of oilseed crops is important (Shekhawat et al.2012). Nine oilseeds crops are the primary source of vegetable oils in the country which are cultivated over an area of about 30.1 million ha accounting for the production of 39.66 million tons (Final Advance Estimates 2023-24 (November-October Ministry of Agriculture) [4]. The domestic supply of edible oil is 12.4 million ton while import is about 16.5 million tons i.e. 57% of the edible oil consumption (NITI Aayog, 2024) [5]. Government of India spends about Rs. 1.38 Lakh Crores (2022-23) to fulfil the demand. Rapeseed-mustard are one of the second largest oilseed crops in India and accounts for 30.3% of the acreage and 33.2% of the production (2023-24) (ICAR-IIRMR, 2024) [3]. With the production of 13.2 million tons during 2023-24, rapeseed-mustard became the first largest oilseed crop in India (ICAR-IIRMR, 2024) [3]. Still, the productivity is major concern in rapeseed and mustard. One of the main factors for low productivity and production of mustard is use of traditional old released varieties and their susceptibility to biotic and abiotic stresses (Bhunia et al. 2017) To realize yield potential of mustard at the rate of state average of 1573 kg/ha, use of high yielding varieties with improved agronomic practices is inevitable especially for western part of Rajasthan. Since development of high yielding varieties of Indian mustard is foremost important task to enhance productivity [8], evaluation of Trombay mustard high yielding genotypes was carried out in collaboration with Bhabha Atomic Research Centre, Mumbai and Agriculture University Jodhpur, Rajasthan and Trombay Jodhpur Mustard 2 (TJM 2) was released and notified for cultivation in 2024.

1. **MATERIAL AND METHODS**

**2.1 Development and evaluation of TJM2**

TJM2 was developed through pedigree method of breeding. TJM 2 is a cross between RB 9902 x TM102. RB9902 is tetralocular genotype with high siliqua density. TM102 is derived from interspecific cross (TM18 Brassica juncea x TDZN582 (B. napus). TM 18 is early genotype isolated from cross TM 4 x Lethbridge and TDZN 582 (Trombay Double Zero napus) is early mutant of Culture 2 (an introduction for Double zero).

Hybridization between these two parents was attempted at Bhabha Atomic Research Centre, Trombay, Mumbai with the objective of development of high yielding and high oil content progenies. Selection in F2 and their advancement in subsequent generations continued, ensuring purity of lines. The best progenies were bulked separately and one of the progenies was named as TM267-3. The breeding line TM 267-3 was then subjected to station trials to evaluate its performance at Bhabha Atomic Research Centre, Trombay, Mumbai. It was evaluated under coordinated trial (AICRP-Zone II) and the material was later shared with Agriculture University Jodhpur for station trial. Based on performance in station trial, multi-location trials conducted at the various centers under Agriculture University, Jodhpur Rajasthan. It was evaluated at twelve locations for four years during the period 2015-16 to 2020-21 in different agro-climatic zones of Rajasthan. As this variety was a collaborative effort of BARC, Trombay, Mumbai and AU, Jodhpur, it was renamed as as Trombay Jodhpur Mustard 2 (TJM 2).

**2.2 Genotyping of TJM 2**

Molecular marker analysis using SSR primers has become a cornerstone in modern varietal development and release processes (Hasan et al., 2021 and Sharma et al., 2018). Therefore, DNA fingerprinting was performed for its distinct identity and for the purpose of varietal release and notification with three check varieties (Bio902, Kranti and Giriraj) using SSR primers. DNA from TM267-3 and check varieties was isolated from leaf tissue using CTAB method. One hundred and twenty-eight microsatellite markers (SSR) were screened to identify the polymorphic marker. The PCR was carried out in 20μl reaction volume consisting 2X PCR Buffer, 0.2 mM of each dNTP, forward and reverse primers (0.5μM), 1U of Taq DNA polymerase (Hi-media), and 40ng DNA template. The PCR reaction conditions were initial denaturation at 95 °C for 5 min, followed by 35 cycles of denaturation at 95°C for 30 secs, annealing at 55°C for 30 secs and extension at 74°C. Final extension was carried out at 74 °C for 10 min after that reaction was held at 4 °C. All the PCR products were resolved on 3% metaphor gel. Primer sequence is given in table 1.

**Table 1. Primer sequence used for Genotyping of TJM 2**

|  |  |  |  |
| --- | --- | --- | --- |
| **Primer name** | **Forward primer sequence (5’-3’)** | **Reverse primer sequence (5’-3’)** | **Ta** |
| Na10E02 | TCGCGCATGTAATCAAAATC | TGTGACGCATCCGATCATAC | 55⁰C |
| Na10F06 | CTCTTCGGTTCGATCCTCG | TTTTTAACAGGAACGGTGGC | 55⁰C |
| Ni2A08 | AGAATTGGGATTTTCATTGAC | TCGTCTTCCAGCTTTCGTTT | 55⁰C |

1. **RESULT AND DISCUSSION**

**3.1 Yield performance evaluation**

A field evaluation was conducted during Rabi 2015–16 at Sri Ganganagar, Rajasthan (AICRP- Zone-II) to assess the performance of the mustard variety TJM 2 (TM 267-3) in comparison to the national check Kranti and the zonal check RGN 229 under timely sown conditions. The results depicted that TJM 2 recorded highest seed yield of 2724 kg/ha and the percent increase in seed yield of TJM 2 over Kranti and RGN 229 was 10.24% and 9.53%, respectively. The oil yield of TJM 2 was 1100 kg/ha which was 9.70% more over Kranti and 10.90% over RGN 229 (Table1).

**Table 2: Performance of TJM 2 for seed yield and oil yield in IVT-Timely sown, Zone-II (Sri-ganganagar, Rajasthan), during Rabi 2015-16 (Annual Report, 2016, AICRP on Rapeseed and Mustard) [1]**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S. No.** | **Location** | **Seed Yield. (Kg/ha)** | **% increase over checks** | **Oil Yield. (Kg/ha)** | **% increase over checks** |
| 1. | TJM 2 (TM 267-3) | **2724** | - | 1100 | - |
| 2. | Kranti (NC) | 2471 | 10.24 | 1003 | 9.70 |
| 3. | RGN229 (ZC) | 2487 | 9.53 | 992 | 10.90 |
| CD (5%) | | 427 | - | - | - |
| CV (%) | | 9.7 | - | - | - |

The performance of TJM 2 for seed yield was evaluated across locations (Zone IA and IIa of Rajasthan) from 2015-16 to 2020-21 and the results show a consistent trend of yield increase compared to check varieties. The overall performance across 12 trials resulted in a weighted mean seed yield of 1831 kg/ha which is higher than checks Bio-902 (1603 kg/ha), Kranti (1597 kg/ha), and RH-749 (1564 kg/ha). The overall increase in seed yield of TJM 2 was 14.20% over Bio-902, 14.63% over Kranti, and 17.08% over RH-749 indicating its consistent superiority in terms of seed yield across the years (Table3).

**Table 3: Average performance of TJM 2 for seed yield in multi-location trials (Rabi 2015-16 to 2020-21) (Research Summary, Rabi 2020-21, Dr. BRC ARS, Mandor) [2]**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Year of Testing** | **No. of Trials** | **Proposed Variety** |  |  |  | **CD (5%)** | **CV (%)** |
| **TJM 2** | **Bio-902 (ZC)** | **Kranti (NC)** | **RH-749 (C)** |
| **Mean Grain Yield (Kg/ha)** | 2015-16 | 3 | 1681 | 1557 | - | - | 309 | 13.92 |
| 2018-19 | 3 | 2116 | 1617 | - | 1670 | 407 | 14.07 |
| 2019-20 | 3 | 1461 | 1331 | 1306 | 1203 | 171 | 8.76 |
| 2020-21 | 3 | 2064 | 1907 | 1888 | 1818 | 214 | 7.28 |
| **Weighted Mean** | **12** | **1831** | **1603** | **1597** | **1564** | **275** | **11.00** |
| **Per cent Increase (+) or Decrease**  **(-) over Checks** | 2015-16 | - | - | 7.96 | - | - | - | - |
| 2018-19 | **-** | - | 30.86 | - | 26.71 | - | - |
| 2019-20 | **-** | - | 9.79 | 11.89 | 21.47 | - | - |
| 2020-21 | **-** | - | 8.26 | 9.35 | 13.56 | - | - |
|  | **Overall Increase** | **-** | - | **14.20** | **14.63** | **17.08** | **-** | **-** |

The oil yield of TJM 2 was evaluated during the Rabi seasons of 2019-20 and 2020-21 under multi-location trials. The results demonstrated that TJM 2 content higher oil yield compared to the check varieties—Bio-902 (ZC), Kranti (NC), and RH-749 (C). The average oil yield over both years was 1117 kg/ha for TJM 2, compared to 1055 kg/ha for Bio-902, 1088 kg/ha for Kranti, and 1059 kg/ha for RH-749. Average, oil yield of TJM 2 was 5.88% increase over Bio-902, 2.67% over Kranti, and 5.48% over RH-749 establishing it as a superior performer in terms of oil and seed yield across diverse environments.

**Table 4: Average performance of TJM 2 for oil yield in multi-location trials (Rabi 2019-20 to 2020-21)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | **Year of Testing** | **Proposed Variety** | **Check Varieties** | | |
| **TJM 2** | **Bio-902 (ZC)** | **Kranti (NC)** | **RH-749 (C)** |
| **Mean oil yield (Kg/ha)** | 2019-20 | 928 | 870 | 916 | 869 |
| 2020-21 | 1305 | 1239 | 1260 | 1249 |
| **Mean** | **1117** | **1055** | **1088** | **1059** |
| **Per cent Increase (+) or Decrease**  **(-) over Checks** | 2019-20 | **-** | 6.67 | 1.31 | 6.79 |
| 2020-21 | **-** | 5.33 | 3.57 | 4.48 |
| **Mean** | **-** | **5.88** | **2.67** | **5.48** |

In field demonstrations across Jodhpur and Nagaur district of Rajasthan, TJM 2 consistently outperformed farmers' practices during 2019-20 to 2021-22. An average seed yield of 2068 kg/ha was recorded showing 14.32% higher seed yield over traditional practices. The variety demonstrated strong adaptability and superior performance under real farming conditions.

**Table 5: Performance of TJM 2 at farmers' field demonstrations**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **No. of Demonstration Conducted (District)** | **Mean Seed Yield (kg/ha)** | | **Yield Increase over FP (%)** |
| **TJM 2 (IP)** | **Farmers Practice (FP)** |
| 2019-20 | Jodhpur (3) | 2050 | 1740 | 17.82 |
| Nagaur (2) | 2105 | 1855 | 13.48 |
| 2020-21 | Jodhpur (10) | 2064 | 1839 | 12.23 |
| 2021-22 | Jodhpur (10) | 2052 | 1802 | 13.87 |
|  | **Mean** | **2068** | **1809** | **14.32** |

**3.1 Varietal characteristics of TJM 2 in comparison to check varieties**

TJM 2 is a promising mustard variety with several desirable traits. It has the reduced plant height (150cm) among the varieties used in trials offering better lodging resistance. It is also early flowering and mature in 121 days compared to checks used in the study, making it suitable for timely harvest. It has 4-5 primary branches with high siliqua density (siliquae per plant -214), 14-17 seed per siliqua and 5.37 g 1000-seed weight. Overall, TJM 2 has a good plant type, better yield contributing traits and timely maturity, making it suitable for timely sowing and harvest. Development of high yielding varieties is continuous process to overcome the constraints of the crop and fulfill the demands of farmers. Dutta et.al. (2019) and Jambhulkar et.al. (2021) have developed the high yielding varieties in mustard as per the need of farmers.

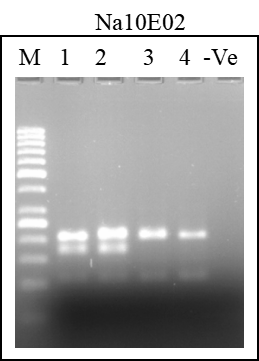
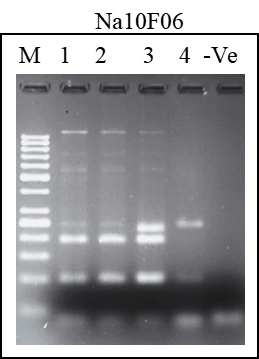
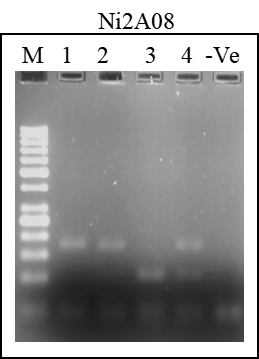


**Fig.1: Trombay Jodhpur Mustard 2 (TJM 2) (TM 267-3)**

**Table 6: Characteristics of TJM2 in comparison to check varieties**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Characters** | **TJM 2** | **Bio 902 (ZC)** | **Kranti (NC)** | **RH 749 (LC)** |
| Plant height (cm) | 150 | 159 | 159 | 163 |
| 50% flowering(days) | 42 | 42 | 43 | 46 |
| Maturity (days) | 121 | 122 | 124 | 125 |
| No. of primary branches/plant | 4.61 | 4.89 | 5.09 | 4.72 |
| No. of siliqua/plant | 214 | 201 | 209 | 202 |
| No. of seeds siliqua | 14 | 14 | 14 | 13 |
| 1000 seed weight (g) | 5.37 | 5.26 | 4.64 | 4.99 |

DNA fingerprinting results revealed that the SSR marker Na10E02 exhibited distinct length polymorphism in TM267-3 compared to the check varieties Bio902, Kranti, and Giriraj, while length polymorphism was also detected between TM267-3 and the check variety Kranti for the SSR marker Na10F06; additionally, the primer Ni2A08 produced a null allele in cv. Kranti compared to TM267-3.



**Fig.2: Agarose gel electrophoresis images**

1. **CONCLUSION**

TJM 2 is a high-yielding mustard variety that has consistently outperformed national and zonal check varieties in both research trials and farmers' field demonstrations across Rajasthan. It exhibits superior seed and oil yields, early maturity, bold seeds, and better plant architecture. Its adaptability under timely sown irrigated conditions and resistance to major diseases and pests make it a suitable choice for mustard growers. With proper management, TJM 2 can yield 14–18 q/ha and has an oil content of 39.2%, making it a promising variety for commercial cultivation.

**DISCLAIMER (Artificial intelligence)**

Option 1: Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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