

# Qualitative phenotypic characterization of monoecious castor (*Ricinus communis* L.) genotypes for seed related traits

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## Abstract

Oil from castor bean (*Ricinus communis* L.) is highly demanding which fetches premium price in the export market. Hence, diverse source of early castor genotypes is obligatory for breeding high yielding early castor cultivars. The present study was taken up using one hundred and twenty-five castor genotypes which were evaluated for the presence of genetic diversity. Phenotypic characterization was done for six qualitative traits. Most of the genotypes possessed varying shades of brown color with caruncle. Ellipsoid seed types were predominant and the secondary color observed among most of the individuals in the population was white. The findings increase the possibility of selection, so it is possible to identify genotypes with better qualitative descriptors aiming to enhance crop yield. This study also serves as a fundamental step pertaining to studies on germination, alkaloid poisoning and stress tolerant castor varieties.

**Key words** – Castor, Characterization, Morpho agronomic features, Seed

## Introduction

Castor (*Ricinus communis* L.,  $2n = 2x = 20$ ) is non-edible oilseed crop with commercial significance of its seed oil. India is the major exporter of castor oil exporting 83 % to China, USA, Japan, Thailand (Lokesh *et al.* 2020). Wide variation was reported among the castor genotypes for morphological traits like seed color (Milani and Nobrega, 2013). Among the phenotypic traits, seed related traits are important for enhancing the seed yield. Seed oil content varied from 48-60% (Brigham, 1993) but it is cumbersome to increase the oil content beyond certain limit. Hence, it is vital to increase the seed yield. Phenotypic characterization are important and powerful tools which were the basic step in any plant breeding programme (Shadid *et al.* 2019). Characterization is the prominent technique to evaluate the existing diversity through phenotypic markers (Bajracharya *et al.* 2006). The use of qualitative characterization based on the phenotype makes the selection process easy and cheap. Thus, gaining knowledge on the available genetic resource is vital to access its variability which ultimately results in parental selection for genetic improvement programs of the castor (Capinan *et al.* 2022). Available literatures on castor characterization are few and scarce. The report presented here is the first of its kind in utilizing monoecious lines of castor to evaluate the variation based on qualitative seed related traits. This would offer immense value in generating information for castor yield improvement. In this regard, the current study was undertaken to characterize the genotypes of castor based on seed related morphometric traits.

## Materials and methods

Plant material for the experiment was 125 monoecious castor genotypes. The experimental location and season were Tapioca and Castor Research Station (TCRS), Yethapur during Rabi 2020. Each test entry was planted in a single row of 5m length, spaced 90 cm both between rows and within plants. Proper crop establishment had been ensured. Data on six qualitative traits *viz.*, presence of secondary coloration (PSC), main seed coloration (MSC), secondary coloration of seeds (SCS), type of secondary coloration (TSC), seed shape (SS) and caruncle protuberance (PDC) were visually scored using the descriptors suggested by Mapa and NBIO (Silva *et al.* 2019). For observable/scorable traits, seeds were categorized visually.

## Results and discussion

### Qualitative phenotypic diversity estimation

For morphological characterization, 125 castor genotypes were evaluated for six seed related traits. A great deal of genetic diversity for morphological attributes was observed among the castor genotypes. Variation in six qualitative characters of 125 castor accessions is illustrated in [Table 1](#). For most of the variables, qualitative traits were well categorized into different phenotypic classes. For example, both ellipsoid and round seed shape were found among the collection. But ellipsoid types were predominant (111) while rounded genotypes were only 14. White was the secondary color observed among the entire population. RG 1673, ICIEEGP 7314, RG 2787 had yellow as the secondary color. Nine different colors were given in the descriptor of which four colors (Medium brown, Light brown, Dark brown and Reddish) were presented in the castor genotypes. The number of genotypes with medium brown was high (69) followed by light brown (25), dark brown (20) and reddish (11). Predominance of different shades of brown was noticed. Caruncle was present in all the genotypes with equal ratio of slight and prominent types (69 and 56 numbers respectively). Type of secondary coloration was given as scored in 75 genotypes, cracked in 48 genotypes and painted in only two genotypes (MI 170 and RG 2822).

Since castor had been utilized in wide ways, they had been widely cultivated across nations. For qualitative evaluation of the collections, we used the descriptors given by Mapa and NBIO ([Silva et al. 2019](#)). One hundred and twenty-five castor germplasm which were medium flowering portrayed considerable morphological diversity for seed related qualitative traits especially main seed color, seed shape and caruncle and also for all the quantitative traits studied. However, secondary seed color was constant for all the genotypes. Seed traits plays an important role in enhancing germination and caruncle was the oil precursor, alkaloid poisoning had been resulted from mottling pattern. Genotypes with round shape with darker outer shell were tolerant to irradiation ([Deepika et al. 2022](#)). Hence, these phenotypic characters will be helpful in yield/economic breeding of castor. These results were in agreement with the findings of [Wahibah et al. \(2020\)](#). Common morphotypes observed among the Indian collections would be of oval shaped, brown colored with mottling on seed coat and with the presence of caruncle. This concurs with the findings of [Anjani \(2000\)](#) who reported the nature and existence of huge diversity within the Indian castor germplasm collections.

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**Table 1. Qualitative phenotypic characterization of 125 castor genotypes for seed related traits**

Genotypes with number codes	Genotypes with number codes						Genotypes with number codes						
	PSC	MSC	SCS	TSC	SS	PDC	PSC	MSC	SCS	TSC	SS	PDC	
1. SKI 215	Present	Medium brown	White	Cracked	Round	Slight	64. GPRG 43	Present	Dark brown	White	Scored	Ellipsoid	Prominent
2. YTP 1	Present	Reddish Medium	White	Scored	Ellipsoid	Prominent	65. GPRG 297	Present	Light brown	White	Scored	Ellipsoid	Slight
3. TMV 5	Present	Medium brown	White	Scored	Ellipsoid	Slight	66. GPJI 356	Present	Light brown	White	Scored	Ellipsoid	Slight
4. ICS 157	Present	Medium brown	White	Scored	Ellipsoid	Slight	67. GPJI 346	Present	Medium brown	White	Cracked	Ellipsoid	Slight
5. MI 175	Present	Medium brown	White	Cracked	Ellipsoid	Prominent	68. GPJI 361	Present	Medium brown	White	Cracked	Ellipsoid	Slight
6. MI 229	Present	Dark brown	White	Cracked	Ellipsoid	Prominent	69. GPJI 4262	Present	Medium brown	White	Cracked	Ellipsoid	Slight
7. RG 2364	Present	Medium brown	White	Cracked	Ellipsoid	Prominent	70. GP 526	Present	Dark brown	White	Scored	Ellipsoid	Slight
8. RG 392	Present	Medium brown	White	Scored	Ellipsoid	Slight	71. GP 5002	Present	Light brown	White	Scored	Ellipsoid	Slight
9. RG 2819	Present	Light brown	White	Scored	Ellipsoid	Slight	72. GP 752	Present	Medium brown	White	Cracked	Ellipsoid	Slight
10. RG 72	Present	Dark brown	White	Cracked	Ellipsoid	Slight	73. GP 729	Present	Medium brown	White	Scored	Ellipsoid	Prominent
11. P 3290	Present	Light brown	White	Cracked	Ellipsoid	Prominent	74. GP 699	Present	Medium brown	White	Scored	Ellipsoid	Slight
12. JC 10	Present	Medium brown	White	Scored	Ellipsoid	Slight	75. GP 789	Present	Medium brown	White	Cracked	Ellipsoid	Prominent
13. GP 674	Present	Light brown	White	Scored	Ellipsoid	Prominent	76. RAJASTHAN LOCAL	Present	Light brown	White	Scored	Ellipsoid	Slight
14. MCI 3	Present	Medium brown	White	Scored	Ellipsoid	Slight	77. MI 180	Present	Medium brown	White	Scored	Round	Slight

15. SKI 301	Present	Dark brown	White	Cracked	Ellipsoi d	Prominent	78. MI 221	Presen t	Medium brown	White	Cracked	Ellipsoi d	Slight
16. MI 223	Present	Medium brown	White	Scored	Ellipsoi d	Slight	79. DCS 105	Presen t	Medium brown	White	Scored	Ellipsoi d	Slight
17. MI 225	Present	Light brown	White	Scored	Ellipsoi d	Slight	80. MI 170	Presen t	Light brown	White	Painted	Ellipsoi d	Slight
18. MI 169	Present	Medium brown	White	Scored	Ellipsoi d	Slight	81. MI 172	Presen t	Medium brown	White	Scored	Ellipsoi d	Slight
19. MI 200	Present	Dark brown	White	Scored	Round	Prominent	82. MI 224	Presen t	Medium brown	White	Cracked	Round	Slight
20. GP 672	Present	Medium brown	White	Cracked	Ellipsoi d	Prominent	83. ICIRG 2262972	Presen t	Medium brown	White	Cracked	Ellipsoi d	Slight
21. GP 783	Present	Dark brown	White	Scored	Round	Slight	84.ICIEEGP 7314	Presen t	Reddish	Yellow	Cracked	Ellipsoi d	Prominent
22. MI 156	Present	Light brown	White	Cracked	Ellipsoi d	Prominent	85. ICIRG 1876213	Presen t	Medium brown	White	Scored	Ellipsoi d	Prominent
23. RG 1941	Present	Dark brown	White	Cracked	Ellipsoi d	Prominent	86.ICIRG 668251	Presen t	Light brown	White	Scored	Ellipsoi d	Slight
24. RG 2104	Present	Light brown	White	Cracked	Ellipsoi d	Slight	87.ICIEEGP 6315	Presen t	Dark brown	White	Cracked	Ellipsoi d	Prominent
25. RG 1673	Present	Reddish	Yello w	Scored	Ellipsoi d	Prominent	88. ICIRG 155	Presen t	Dark brown	White	Cracked	Ellipsoi d	Prominent
26. RG 1771	Present	Medium brown	White	Cracked	Ellipsoi d	Slight	89. RG 2787	Presen t	Dark brown	Yellow	Scored	Ellipsoi d	Prominent
27. JC 12	Present	Light brown	White	Cracked	Ellipsoi d	Prominent	90. JC 3	Presen t	Medium brown	White	Scored	Ellipsoi d	Slight
28. JI 335	Present	Medium brown	White	Cracked	Ellipsoi d	Slight	91. GPJI 378	Presen t	Medium brown	White	Scored	Ellipsoi d	Prominent
29. MCI 8	Present	Medium brown	White	Scored	Round	Prominent	92. DCS 9	Presen t	Medium brown	White	Scored	Ellipsoi d	Slight
30. JI 397	Present	Medium brown	White	Scored	Ellipsoi d	Prominent	93. GPRG 1258	Presen t	Medium brown	White	Scored	Ellipsoi d	Slight
31. JI 35	Present	Dark brown	White	Scored	Ellipsoi d	Slight	94. MI 151	Presen t	Medium brown	White	Scored	Ellipsoi d	Slight

32. SKI 335	Present	Medium brown	White	Cracked	Ellipsoi d	Prominent	95. MI 230	Presen t	Medium brown	White	Cracked	Ellipsoi d	Slight
33. ICS 186	Present	Reddish	White	Cracked	Ellipsoi d	Prominent	96.ICIRG 261457	Presen t	Light brown	White	Scored	Ellipsoi d	Slight
34. ICS 161	Present	Reddish	White	Scored	Ellipsoi d	Prominent	97. ICIRG 1727156	Presen t	Dark brown	White	Cracked	Ellipsoi d	Prominent
35. ICS 154	Present	Medium brown	White	Cracked	Ellipsoi d	Prominent	98. ICIRG 2272103	Presen t	Medium brown	White	Cracked	Round	Prominent
36. ICS 182	Present	Reddish	White	Scored	Ellipsoi d	Slight	99. ICIRG 28004	Presen t	Dark brown	White	Scored	Round	Prominent
37. GP 471	Present	Medium brown	White	Scored	Ellipsoi d	Slight	100. ICIRG 2262962	Presen t	Medium brown	White	Scored	Ellipsoi d	Prominent
38. GP 568	Present	Dark brown	White	Cracked	Ellipsoi d	Prominent	101. ICIRG 8982	Presen t	Reddish	White	Cracked	Ellipsoi d	Slight
39. MI 232	Present	Light brown	White	Cracked	Ellipsoi d	Slight	102. GPRG 3561	Presen t	Medium brown	White	Scored	Ellipsoi d	Prominent
40. MI 173	Present	Medium brown	White	Scored	Ellipsoi d	Slight	103. GPRG 3748	Presen t	Medium brown	White	Scored	Ellipsoi d	Slight
41. TMV 6	Present	Light brown	White	Cracked	Ellipsoi d	Prominent	104. GPJI 409	Presen t	Medium brown	White	Cracked	Ellipsoi d	Prominent
42. SKI 304	Present	Medium brown	White	Cracked	Ellipsoi d	Slight	105. GPSKI 271	Presen t	Dark brown	White	Cracked	Ellipsoi d	Prominent
43. JC 8	Present	Medium brown	White	Scored	Ellipsoi d	Slight	106. GPJI 415	Presen t	Dark brown	White	Scored	Ellipsoi d	Prominent
44. SKI 352	Present	Medium brown	White	Scored	Ellipsoi d	Slight	107. GPJI 380	Presen t	Medium brown	White	Cracked	Ellipsoi d	Slight
45. DCS 85	Present	Medium brown	White	Cracked	Ellipsoi d	Prominent	108. GP 680	Presen t	Light brown	White	Scored	Round	Slight
46. MI 201	Present	Medium brown	White	Scored	Ellipsoi d	Slight	109. GP 705	Presen t	Light brown	White	Cracked	Ellipsoi d	Slight
47. MI 197	Present	Medium brown	White	Scored	Round	Slight	110. GP 493	Presen t	Medium brown	White	Scored	Ellipsoi d	Slight
48. MI 149	Present	Medium brown	White	Cracked	Round	Slight	111. MI 152	Presen t	Light brown	White	Scored	Ellipsoi d	Prominent

49. ICIRG 27871529	Present	Reddish	White	Scored	Ellipsoi d	Prominent	112. DCS 106	Presen t	Medium brown	White	Scored	Ellipsoi d	Slight
50. RG 22	Present	Dark brown	White	Cracked	Ellipsoi d	Prominent	113. MCI 11	Presen t	Light brown	White	Scored	Ellipsoi d	Prominent
51. RG 1608	Present	Light brown	White	Scored	Ellipsoi d	Prominent	114. MI 211	Presen t	Medium brown	White	Cracked	Ellipsoi d	Prominent
52. RG 3160	Present	Light brown	White	Scored	Ellipsoi d	Slight	115. ICIRG 27461	Presen t	Reddish	White	Cracked	Ellipsoi d	Prominent
53. RG 2722	Present	Medium brown	White	Scored	Ellipsoi d	Prominent	116. ICIRG 2612314	Presen t	Medium brown	White	Scored	Ellipsoi d	Slight
54. RG 2822	Present	Medium brown	White	Painted	Ellipsoi d	Prominent	117. ICIRG 8983	Presen t	Reddish	White	Scored	Ellipsoi d	Slight
55. RG 18	Present	Medium brown	White	Scored	Round	Prominent	118. GPRG 4713	Presen t	Dark brown	White	Scored	Ellipsoi d	Prominent
56. RG 1624	Present	Reddish	White	Cracked	Ellipsoi d	Prominent	119. GP 487	Presen t	Medium brown	White	Scored	Ellipsoi d	Slight
57. RG 2818	Present	Medium brown	White	Scored	Ellipsoi d	Prominent	120. JI 319	Presen t	Light brown	White	Scored	Ellipsoi d	Prominent
58. JI 330	Present	Light brown	White	Scored	Ellipsoi d	Slight	121. MI 210	Presen t	Medium brown	White	Scored	Ellipsoi d	Slight
59. TNPT 4	Present	Medium brown	White	Scored	Ellipsoi d	Prominent	122. MI 202	Presen t	Medium brown	White	Scored	Round	Slight
60. JI 220	Present	Medium brown	White	Scored	Ellipsoi d	Slight	123. GP 759	Presen t	Medium brown	White	Scored	Ellipsoi d	Slight
61. MCI 7	Present	Dark brown	White	Cracked	Ellipsoi d	Prominent	124. MI 167	Presen t	Medium brown	White	Scored	Ellipsoi d	Slight
62. 48-1	Present	Light brown	White	Cracked	Round	Slight	125. MI 168	Presen t	Medium brown	White	Scored	Ellipsoi d	Slight
63. DCS 107	Present	Medium brown	White	Scored	Ellipsoi d	Prominent							

PSC - presence of secondary coloration; MSC - main seed coloration; SCS - secondary coloration of seeds; TSC - type of secondary coloration; SS - seed shape; PDC - caruncle protuberance