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# DUS STUDY OF AROMATIC RICES OF CHHATTISGARH, INDIA

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## Abstract

Chhattisgarh is rich and well known for its diversity of rice. The wild relatives, cultivated types, aromatic and non-aromatic rice have very vast diversity present throughout the state. Aromatic rice constitutes a small and special group of rices that regarded as best in quality and usually used in preparation of special dishes. In Chhattisgarh, each district has a unique defined aromatic rice variety in earlier days, it was prominently grown by the farmers of that region and gave unique identity to that region by the name of that rice like, Vishnubhog in Pendra, Jeeraphool of Ambikapur, Shyamjeera of Surajpur, Bisni of Bagicha, Badshahbhog of Jagdalpur etc. With the expansion of high yielding varieties, these rice varieties were replaced and now they are nearly finished or vanished from the fields of farmers. Very few farmers are cultivating these varieties for their consumption, but these are in much demand by consumers. No systematic studies have been done so far regarding characterization or distinguishing traits of traditional aromatic rice varieties, hence no identifying features of these varieties are so far revealed. Traders are selling any thing by the name of these varieties. Present study is based on 45 morphological DUS traits of rice and their descriptors. The unique identifying features of aromatic rices were identified in this study. The present study distinguishes each variety from other on the basis of their morphological traits. Fourty five unique morphological traits exhibited variability expect ligule colour. Grain size, grain shape and plant height contributing highest diversity.

***Key words :*** DUS, aromatic rice, characterization, morphological.

## Introduction

Rice is one of the very few crop species endowed with rich genetic diversity, which account over 100,000 landraces and improved cultivars and make it one of the most researched crop with wealth of scientific literature on all its aspects (Patel, 2012). Rice (*Oryza sativa* L.) is one of the most important staple food crops of Chhattisgarh. In Chhattisgarh, it is mainly grown under rainfed ecosystem, which covers about 74, 97 and 95 per cent cropped area of Chhattisgarh plain, Bastar plateau and Northern hill zones, respectively. The central plains of Chhattisgarh are known as rice bowl of central India. Besides basmati types, which get high price in international market, the country also bounds with hundreds of indigenous short grain aromatic cultivars and landraces grown in pockets of different states. Almost every state of India has its own collection of aromatic rice that performs well in native areas (Rani and Krishnaiah, 2001).

Most of the information, we have so far is about common varieties and our knowledge about aromatic rice is still incomplete. An ever increasing global demand for aromatic rice has been noted in the recent times. Chaudhary *et al*. (2003) have discussed the economic aspects of aromatic rice detailing current trends, consumption pattern and global market demands.

Evaluation and characterization of potential varieties should form an important constituent of these collection efforts because of their in-built genetic variability due to several generations of growing and selection by breeders and farmers. However, the utilization of these rice genetic resources had been limited to only adaptable genotypes (Caldo *et al*., 1996). As a result, the diversity of these genetic resources is being lost to the need for higher yields and early maturity. However, a successful breeding program will depend on the genetic diversity of a crop for achieving the goals of improving the crop and producing high yielding and better resistant varieties (Padulosi, 1993). Therefore, there is the need to diversify the genetic base of improved rice varieties and the first step towards this is to evaluate and characterize available rice germplasm or genotypes at both the morphological and molecular levels. This is because the evaluation of phenotypic diversity usually reveals important traits of interest to plant breeders (Singh, 1989).

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Indian sub continent is a home for aromatic rice diversity. Aroma quality of scented rice is a major character, which increases the value of rice in international market (Nayak *et al*., 2002). The demand for special purpose aromatic rice has dramatically increased over the past two decades. India emerges as one of the major exporter of rice in international markets. The success of any breeding program depends upon the selection of the parents for hybridization.

Number of landraces are still cultivated locally, but most of them are being rapidly replaced by improved cultivars due to increasing narrowing of genetic base. The adoption of new varieties means that the area planted to landraces are gradually disappearing (Guei, 2000). Thus, reduced genetic variability underscores the need to collect landraces for *ex situ* conservation and to characterize them for future rice breeding programs at morphological and molecular levels because the evaluation of phenotypic diversity usually reveals important traits of interest to plant breeders (Singh, 1989).

## Materials and Methods

Collection and characterization of existing germplasm is not only important for utilizing the appropriate attribute based donors in breeding program, but is also essential in the present era for protecting the unique rice. A total of 38 aromatic rice accessions were selected from a collection of aromatic rice germplasm in I.G.K.V., Raipur (C.G.), India. Morphological descriptors are presented in table 1. Twenty one days old seedlings were transplanted with a spacing of 20cm and 15cm between rows and between plants, respectively. Observations were recorded on five randomly selected plants for 45 morphological and quality descriptors *viz*., 1. Coleoptile color with classes colorless (1), green(2), purple(3), 2. Basal leaf sheath color with classes green(1), light purple(2), purple lines(3), purple(4), 3. Intensity of green color on leaf with classes light(3), medium(5), dark(7), 4. Anthocyanin coloration of leaf with classes Absent(1), present(9), 5. Distribution of anthocyanin coloration on leaf with classes on tips only(1), on margins only(2), in blotches only(3), uniform(4), 6. Anthocyanin coloration on leaf sheath with classes Absent(1), present(9), 7. Intensity of anthocyanin coloration on leaf sheath with classes very weak(1), weak(3), medium(5), strong(7), very strong(9), 8. Presence of pubescence on leaf blade surface with classes Absent(1), weak(3), medium(5), strong(7), very strong(9), 9. Presence of auricles with classes with classes Absent(1), present(9), 10. Anthocyanin coloration of auricles with classes Colourless(1), light purple(2), purple(3), 11. Presence of collar on leaves with classes Absent(1), present(9), 12. Anthocyanin coloration of collar with classes Absent(1,) present(9), 13. Presence of ligule on leaf with classes Absent(1) present(9), 14. Shape of ligule with classes Truncate(1), acute(2), split(3), 15. Color of ligule with classes Green(1), light purple(2), purple(3), 16. Length of leaf blade with classes Short(3), medium(5), long (7), 17. Width of leaf blade with classes Narrow(3), medium(5), broad(7), 18. Culm: attitude with classes erect(1), semierect(3), open(5), spreading(7), 19. Attitude of flag leaf blade with classes Erect(1), semierect(3), horizontal(5), deflexed(7), 20. Density of pubescence of lemma with classes Absent(1), weak(3), medium(5), strong(7), very strong(9), 21. Color of stigma with classes White(1), light green(2), yellow(3), light purple(4), purple(5), 22. Anthocyanin coloration of nodes with classes Absent(1), present(9), 23. Intensity of anthocyanin coloration of nodes with classes Weak(3), medium(5), strong(7), 24. Anthocyanin coloration of internodes with classes Absent(1), present(9), 25. Attitude of flag leaf blade at late stage with classes Erect(1), semi-erect(3), horizontal(5), deflexed(7), 26. Curvature of main axis of panicle with classes Straight(1), semi-straight(3), drooping(5), deflexed(7), 27. Color of tip of lemma at ripening with classes White(1), yellowish(2), brown(3), red(4), purple(5), black(6), 28. Color of lemma and palea with classes Straw(1), gold and gold furrows on straw background(2), brown spots on straw(3), brown furrows on straw(4), brown ( tawny)(5), reddish to light purple(6), purple spots on straw(7), purple furrows on straw(8), purple(9), black(10), 29. Presence of awns on panicles with classes Absent(1), present(9), 30. Color of awns with classes yellowish white(1), yellowish brown(2), brown(3), reddish brown(4), light red(5), red(6), light purple(7), purple(8), black(9), 31. Distribution of awns with classes tip only(1), upper half only(3), whole length(5), 32. Presence of secondary branching on panicles with classes Absent(1), present(9), 33. Density of secondary branching on panicles with classes Weak(1), strong(2), clustered(3), 34. Attitude of branches with classes Erect(1), erect to semi-erect(3), semi-erect(5), semi-erect to spreading(7), spreading(9), 35. Exertion of panicle with classes partly exserted(3), exserted(5), well exserted(7), 36. Leaf senescence with classes Early(3), medium(5), late(7), 37. Days to 50 percent flowering with classes very early(<71 days)(1), early(71-90 days)(3), medium(91-110 days) (5), late(111-130 days)(7), 38.Stem/culm length (cm) with classes very short(<91 cm)(1), short(91-110 cm)(3),medium (111-130 cm)(5), long (131-150 cm)(7), very long (>150 cm)(9), 39.Panicle length (cm) with classes very short (<16

cm)(1), short (16-20 cm)(3), medium (21-25 cm)(5), long (26-30 cm)(7), very long (>30 cm)(9), 40. Thousand seed weight(g) with classes very low(1), low(3), medium(5), high(7), very high(9), 41. Kernel length with classes very short(1), short(3), medium(5), long(7), very long(9), 42. Kernel breadth with classes very narrow(1), narrow(3), medium(5), broad(7), very broad(9), 43. Amylose content with classes very low (<10%)(1), low(10-19%)(3), medium(20-25%)(5), high(26-30%)(7), very high (>30%)(9), 44. Alkali spreading value with classes Low(1), medium(3), high medium(5), high(7) and 45. Aroma with classes Absent(1), present(9).

## Results and Discussion

Forty five morphological characters were recorded for 38 accessions. The morphological characters included 1. Coleoptile color 2. Basal leaf sheath color 3. Intensity of green color on leaf 4. Anthocyanin coloration of leaf 5. Distribution of anthocyanin coloration on leaf 6. Anthocyanin coloration on leaf sheath 7. Intensity of anthocyanin coloration on leaf sheath 8. Presence of pubescence on leaf blade surface 9. Presence of auricles 10. Anthocyanin coloration of auricles 11. Presence of collar on leaves 12. Anthocyanin coloration of collar 13. Presence of ligule on leaf 14. Shape of ligule 15. Color of ligule 16. Length of leaf blade 17. Width of leaf blade 18. Culm : attitude 19. Attitude of flag leaf blade 20. Density of pubescence of lemma 21. Color of stigma 22. Anthocyanin coloration of nodes 23. Intensity of anthocyanin coloration of nodes 24. Anthocyanin coloration of internodes 25. Attitude of flag leaf blade at late stage 26. Curvature of main axis of panicle 27. Color of tip of lemma at ripening 28. Color of lemma and palea 29. Presence of awns on panicles 30. Color of awns 31. Distribution of awns 32. Presence of secondary branching on panicles 33. Density of secondary branching on panicles 34. Attitude of branches 35. Exertion of panicle 36. Leaf senescence 37. Days to 50 percent flowering 38. Stem/culm length (cm) 39. Panicle length (cm) 40. Thousand seed weight(g) 41. Kernel length 42. Kernel breadth 43. Amylose content 44. Alkali spreading value and 45. Aroma. The results of morphological characters recorded for 38 accessions are discussed in table 2 (Character 1 to 45). Out of 38 landraces 76% showed colorless coleoptiles whereas 13% showed green and only 11% had purple coleoptile color. Out of 38 landraces 89% showed green basal leaf sheath color, 5% showed purple whereas 3% had light purple basal leaf sheath color and 3% showed purple line basal leaf sheath color. Maximum numbers of entries (26) *i.e*. 68% were showing medium green color of leaf, 21% of genotypes having dark green leaf blade and only four landraces *i.e*. 11% having light green leaf blade color.

Out of 38 landraces 50% showed weak pubescence on leaf, 24% showed medium, 18% had strong whereas 3% had very strong pubescence on leaf and 5% showed absence of pubescence on leaf. Out of 38 landraces 63% showed colorless auricles whereas, 24% showed light purple and only 13% had dark purple auricles. 63% landraces were recorded split ligule shape, 37% landraces were have acute ligule shape and truncate ligule shape was not observed in any entry. Out of thirty eight entries, 92% landraces were green ligule color, 5% landraces having light purple ligule color and 3% landrace showed purple ligule color. Out of thirty eight landraces, 76% landraces were having late flowering, 19% landraces were showing medium flowering duration and only 5% landraces were having early flowering. On the basis of stigma color rice entries were grouped into 5 categories *viz.*, white, light green, yellow, light purple and purple color of stigma. 57% landraces showed white color of stigma, 26% landraces were showed yellow color of stigma, 11% landraces were observed purple color stigma whereas in 3% landrace were recorded light purple color of stigma and only one land race showed light green color of stigma. Curvature of main axis of panicle is classified into 4 classes as straight, semi- straight, drooping and deflexed. 45% landraces, 34% landraces were recorded semi-straight panicle curvature. 16% landraces were drooping panicle and only in 5% landraces were recorded deflexed panicle curvature. Density of pubescence on lemma was classified as absent, weak, medium, strong and very strong classes. Out of thirty eight landraces, 53% landraces were showed medium pubescence on lemma. 31% landraces were having strong pubescence on lemma. 13% landraces were showed weak pubescence and only in 3% landrace pubescence on lemma was absent.

Out of 38 landraces 42% showed strong density of secondary branching, whereas 32% showed weak and only 26% had clustered density of secondary branching. Panicle exertions are divided into 3 classes *viz.*, exerted, partially exerted and well exerted panicle. 66% landraces were observed well exerted panicle. 34% landraces were showed exerted panicle. Lemma and palea color was categorized into 10 classes. Out of thirty eight landraces, 47% landraces were observed straw color of lemma and palea. 16% landraces were recorded purple color of lemma and palea. 16% landraces recorded brown furrow on straw color of lemma and palea whereas 13% landraces were showed brown lemma and palea color and only in 8% landraces recorded purple furrow on straw

**Table 1 :** Descriptors and their codes of 45 morphological traits examined.

| S. no. | Characteristics | Description | Growth stage |
|---|---|---|---|
| 1. | Coleoptiles color | colourless (1), green(2), purple(3) | First leaf stage |
| 2. | Basal leaf sheath color | Green(1), light purple(2), purple lines(3), purple(4) | Early boot stage |
| 3. | Intensity of green color on leaf | Light(3), medium(5), dark(7) | Early boot stage |
| 4. | Anthocyanin coloration of leaf | Absent(1), present(9) | Early boot stage |
| 5. | Distribution of anthocyanin coloration on leaf | On tips only(1), on margins only(2), in blotches only(3), uniform(4) | Early boot stage |
| 6. | Anthocyanin coloration on leaf sheath | Absent(1), present(9) | Early boot stage |
| 7. | Intensity of anthocyanin coloration on leaf sheath | Very weak(1), weak(3), medium(5), strong(7), very strong(9) | Early boot stage |
| 8. | Presence of pubescence on leaf blade surface | Absent(1), weak(3), medium(5), strong(7), very strong(9) | Early boot stage |
| 9. | Presence of auricles | Absent(1), present(9) | Early boot stage |
| 10. | Anthocyanin coloration of auricles | Colourless(1), light purple(2), purple(3) | Early boot stage |
| 11. | Presence of collar on leaves | Absent(1), present(9) | Early boot stage |
| 12. | Anthocyanin coloration of collar | Absent(1,) present(9) | Early boot stage |
| 13. | Presence of ligule on leaf | Absent(1), present(9) | Early boot stage |
| 14. | Shape of ligule | Truncate(1), acute(2), split(3) | Early boot stage |
| 15. | Color of ligule | Green(1), light purple(2), purple(3) | Early boot stage |
| 16. | Length of leaf blade | Short(3), medium(5), long (7) | Early boot stage |
| 17. | Width of leaf blade | Narrow(3), medium(5), broad(7) | Early boot stage |
| 18. | Culm: attitude | Erect(1),semi-erect(3), open(5), spreading(7) | Early boot stage |
| 19 | Attitude of flag leaf blade | Erect(1), semi-erect(3), horizontal(5), deflexed(7) | Beginning of anthesis |
| 20. | Density of pubescence of lemma | Absent(1), weak(3), medium(5), strong(7), very strong(9) | Beginning of anthesis to dough development |
| 21. | Color of stigma | White(1), light green(2),yellow(3), light purple(4), purple(5) | Anthesis half-way |
| 22. | Anthocyanin coloration of nodes | Absent(1), present(9) | Milk development |
| 23. | Intensity of anthocyanin coloration of nodes | Weak(3), medium(5), strong(7) | Milk development |
| 24. | Anthocyanin coloration of internodes | Absent(1), present(9) | Milk development |
| 25. | Attitude of flag leaf blade at late stage | Erect(1), semi-erect(3), horizontal(5), deflexed(7) | Ripening stage |
| 26. | Curvature of main axis of panicle | Straight(1), semi-straight(3), drooping(5), deflexed(7) | Ripening stage |
| 27. | Color of tip of lemma at ripening | White(1), yellowish(2), brown(3), red(4), purple(5), black(6) | Dough development to ripening |

***Table 1 continued...***

***Table 1 continued...***

| | | | |
|---|---|---|---|
| 28. | Color of lemma and palea | Straw(1), gold and gold furrows on straw background(2), brown spots on straw(3), brown furrows on straw(4),brown (tawny)(5), reddish to light purple(6), purple spots on straw(7), purple furrows on straw(8), purple(9), black(10) | Dough development to ripening |
| 29. | Presence of awns on panicles | Absent(1), present(9) | Ripening stage |
| 30. | Color of awns | Yellowish white(1), yellowish brown(2), brown(3), reddish brown(4), light red(5), red(6), light purple(7), purple(8), black(9) | Ripening stage |
| 31. | Distribution of awns | Tip only(1), upper half only(3), whole length(5) | Ripening stage |
| 32. | Presence of secondary branching on panicles | Absent(1), present(9) | Ripening stage |
| 33. | Density of secondary branching on panicles | Weak(1), strong(2), clustered(3) | Ripening stage |
| 34. | Attitude of branches | Erect(1), erect to semi-erect(3), semi-erect(5), semi-erect to spreading(7), spreading(9) | Ripening stage |
| 35. | Exertion of panicle | Partly exerted(3), exerted(5), well exerted(7) | Ripening stage |
| 36. | Leaf senescence | Early(3), medium(5), late(7) | Caryopsis hard |
| 37. | Days to 50 percent flowering | Very early (<71 days)(1), early (71-90 days)(3), medium (91-110 days)(5), late (111-130 days)(7), very late (>130 days)(9) | Ripening stage |
| 38. | Stem/Culm length (cm) | Very short (<91 cm)(1), short (91-110 cm)(3), medium (111-130 cm)(5), long (131-150 cm)(7), very long (>150 cm)(9) | Milk development |
| 39. | Panicle length (cm) | Very short (<16 cm)(1), short (16-20 cm)(3), medium (21-25 cm)(5), long (26-30 cm)(7), very long (>30 cm)(9) | Milk development to Ripening stage |
| 40. | Thousand seed weight(g) | Very low(1), low(3), medium(5), high(7), very high(9) | Caryopsis hard |
| 41. | Kernel length | Very short(1), short(3), medium(5), long(7), very long(9) | Caryopsis hard |
| 42. | Kernel breadth | Very narrow(1), narrow(3), medium(5), broad(7), very broad(9) | Caryopsis hard |
| 43. | Amylose content | Very low (<10%)(1), low(10-19%)(3), medium(20-25%)(5), high(26-30%)(7), very high (>30%)(9) | Caryopsis hard |
| 44. | Alkali spreading value | Low(1), medium(3), high medium(5), high(7) | Caryopsis hard |
| 45. | Aroma | Absent(1), present(9) | Caryopsis hard |

color of lemma and palea. Out of twelve landraces, 83% landraces showed awn in whole length of panicle and only in 17% landraces awn on tips of panicle. On the basis of amylose content the thirty eight landraces were classified into 5 classes *viz.*, very low, low, medium, high and very high amylose content. 47% landraces were observed very high content of amylose. 21% landraces were showed low amylose content whereas in 19% were recorded medium amylose content, only 13% landraces had very low amylose content. 53% landraces grouped into low gelatinization temperature, 31% landraces recorded medium gelatinization temperature, 16% landraces showed high medium gelatinization temperature

All genotypes were classified into two classes *i.e.*, presence or absence of aroma. Aroma was present in all thirty eight landraces. All the landraces were found to have aroma both in leaves and grain. It was difficult to classify different genotypes on the basis of intensity of aroma. Aroma in rice has been reported to be simply inherited by one or two recessive genes. These indigenous aromatic rice having a lot of potential for various traits and could be used for further improvement for incorporating certain important and valuable traits. The basic study on genotypes for yield contributing characters of traditional aromatic varieties and other quality traits would help in making precised breeding strategies

**Table 2 :** Morphological traits of thirty eight aromatic rice germplasm.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Anterved | 3 | 1 | 7 | 1 | - | 1 | - | 3 | 9 | 2 | 9 | 1 | 9 | 3 | 1 | 7 | 7 | 1 | 3 | 5 | 1 | 1 | - | 1 | 3 | 7 | 1 | 5 |
| Atmasheetal | 2 | 1 | 5 | 1 | - | 1 | - | 3 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 5 | 5 | 7 | 7 | 1 | 5 | 1 | - | 1 | 1 | 1 | 5 | 1 |
| Badshahbhog | 2 | 1 | 5 | 1 | - | 1 | - | 7 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 5 | 5 | 1 | 1 | 5 | 1 | 1 | - | 1 | 1 | 3 | 2 | 5 |
| Bisni | 2 | 1 | 5 | 1 | - | 1 | - | 5 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 5 | 7 | 7 | 3 | 3 | 3 | 1 | - | 1 | 3 | 1 | 1 | 1 |
| Chinnor –I | 2 | 1 | 3 | 1 | - | 1 | - | 3 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 3 | 7 | 1 | 5 | 5 | 1 | 1 | - | 1 | 5 | 3 | 1 | 1 |
| Chinnor-II | 2 | 1 | 3 | 1 | - | 1 | - | 3 | 1 | 1 | 9 | 1 | 9 | 3 | 1 | 7 | 7 | 1 | 1 | 7 | 1 | 1 | - | 1 | 1 | 3 | 1 | 1 |
| Dubraj-I | 2 | 1 | 5 | 1 | - | 1 | - | 3 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 7 | 7 | 1 | 1 | 7 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 |
| Dubraj-II | 2 | 1 | 5 | 1 | - | 1 | - | 3 | 9 | 2 | 9 | 1 | 9 | 3 | 1 | 7 | 7 | 1 | 1 | 7 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 |
| Dubraj-III | 2 | 1 | 5 | 1 | - | 1 | - | 3 | 9 | 2 | 9 | 1 | 9 | 3 | 1 | 7 | 7 | 1 | 1 | 7 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 |
| Dujai | 3 | 4 | 5 | 1 | - | 1 | - | 3 | 9 | 3 | 9 | 9 | 9 | 3 | 1 | 7 | 7 | 1 | 3 | 5 | 5 | 9 | 7 | 1 | 3 | 1 | 5 | 1 |
| Elaychi | 2 | 1 | 5 | 1 | - | 1 | - | 3 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 7 | 7 | 7 | 5 | 5 | 1 | 1 | - | 1 | 3 | 5 | 1 | 1 |
| Gopalbhog | 3 | 1 | 3 | 1 | - | 1 | - | 3 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 3 | 7 | 1 | 1 | 3 | 3 | 1 | - | 1 | 1 | 1 | 5 | 4 |
| Gangabaru | 2 | 1 | 5 | 1 | - | 1 | - | 3 | 9 | 3 | 9 | 1 | 9 | 3 | 1 | 5 | 5 | 7 | 1 | 7 | 1 | 1 | - | 1 | 1 | 3 | 1 | 1 |
| Jaigundi | 3 | 1 | 5 | 1 | - | 1 | - | 5 | 9 | 2 | 9 | 1 | 9 | 3 | 1 | 7 | 7 | 1 | 3 | 5 | 1 | 1 | - | 1 | 3 | 5 | 6 | 4 |
| Javaphool | 2 | 1 | 5 | 1 | - | 1 | - | 3 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 5 | 7 | 1 | 3 | 5 | 1 | 1 | - | 1 | 3 | 1 | 1 | 1 |
| Jeeradhan | 2 | 1 | 7 | 9 | 1 | 1 | - | 5 | 1 | 1 | 9 | 1 | 9 | 3 | 1 | 7 | 7 | 1 | 5 | 3 | 3 | 1 | - | 1 | 5 | 3 | 5 | 9 |
| Jeeraphool | 2 | 1 | 5 | 1 | - | 1 | - | 3 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 5 | 7 | 1 | 3 | 5 | 1 | 1 | - | 1 | 3 | 1 | 1 | 1 |
| Jaophool | 2 | 1 | 5 | 1 | 1 | 1 | - | 5 | 9 | 1 | 9 | 9 | 9 | 3 | 1 | 5 | 5 | 3 | 3 | 5 | 1 | 9 | - | 1 | 3 | 3 | 1 | 1 |
| Kalikamod | 3 | 1 | 7 | 1 | - | 1 | - | 5 | 9 | 2 | 9 | 1 | 9 | 3 | 1 | 5 | 7 | 1 | 1 | 5 | 1 | 1 | - | 1 | 1 | 3 | 5 | 9 |
| Kapoorsar | 2 | 1 | 5 | 1 | - | 1 | - | 3 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 5 | 3 | 7 | 5 | 3 | 2 | 1 | - | 1 | 5 | 1 | 2 | 10 |
| Kasturi | 1 | 1 | 5 | 1 | - | 1 | - | 7 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 5 | 7 | 3 | 1 | 7 | 5 | 1 | - | 1 | 1 | 7 | 5 | 4 |
| Kharigilas | 2 | 4 | 7 | 9 | 2 | 9 | 7 | 9 | 9 | 3 | 9 | 9 | 9 | 3 | 2 | 7 | 7 | 7 | 3 | 7 | 5 | 9 | 7 | 9 | 3 | 3 | 5 | 9 |
| Katarnibhog | 2 | 1 | 5 | 1 | - | 1 | - | 7 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 5 | 5 | 1 | 5 | 5 | 1 | 1 | - | 1 | 5 | 3 | 1 | 1 |
| Kheraghul | 2 | 1 | 5 | 1 | - | 1 | - | 5 | 9 | 2 | 9 | 1 | 9 | 3 | 1 | 5 | 5 | 1 | 3 | 3 | 3 | 1 | - | 1 | 1 | 1 | 5 | 1 |
| Kubrimohar-I | 2 | 1 | 5 | 1 | - | 1 | - | 3 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 5 | 5 | 1 | 1 | 7 | 4 | 1 | - | 1 | 1 | 5 | 1 | 4 |
| Kubrimohar-II | 2 | 1 | 5 | 1 | - | 1 | - | 3 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 5 | 5 | 1 | 1 | 5 | 3 | 1 | - | 1 | 1 | 3 | 2 | 4 |
| Lalloo-14 | 2 | 1 | 7 | 1 | - | 1 | - | 7 | 1 | 1 | 9 | 1 | 9 | 3 | 1 | 7 | 7 | 7 | 3 | 5 | 1 | 1 | - | 1 | 3 | 5 | 3 | 5 |
| Londhi | 2 | 1 | 3 | 1 | - | 1 | - | 5 | 9 | 2 | 9 | 9 | 9 | 3 | 1 | 7 | 7 | 1 | 5 | 7 | 1 | 1 | - | 1 | 5 | 5 | 2 | 5 |
| Mai Dubraj | 2 | 1 | 5 | 1 | - | 1 | - | 5 | 9 | 2 | 9 | 1 | 9 | 3 | 1 | 7 | 7 | 7 | 1 | 7 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 |
| Samudrafan | 3 | 1 | 7 | 9 | 1 | 1 | - | 7 | 9 | 1 | 9 | 1 | 9 | 3 | 3 | 7 | 5 | 7 | 5 | 7 | 1 | 1 | - | 1 | 5 | 5 | 5 | 8 |
| Shyamjeera | 3 | 1 | 5 | 9 | 2 | 9 | 5 | 7 | 9 | 3 | 9 | 1 | 9 | 3 | 2 | 5 | 5 | 1 | 3 | 5 | 1 | 1 | - | 1 | 3 | 3 | 5 | 9 |
| Srikamal | 3 | 1 | 7 | 1 | - | 1 | - | 7 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 7 | 5 | 1 | 1 | 5 | 3 | 1 | - | 1 | 1 | 1 | 2 | 4 |
| Sukalaphool | 2 | 1 | 7 | 9 | 2 | 1 | - | 3 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 7 | 5 | 1 | 1 | 1 | 3 | 1 | - | 1 | 1 | 1 | 5 | 8 |
| Tilkasturi | 2 | 1 | 5 | 1 | - | 1 | - | 5 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 5 | 5 | 1 | 1 | 5 | 3 | 1 | - | 1 | 1 | 1 | 5 | 9 |
| Tulasiprasad | 2 | 1 | 5 | 1 | - | 1 | - | 3 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 7 | 7 | 1 | 3 | 5 | 3 | 1 | - | 1 | 3 | 1 | 5 | 8 |
| Tulsimanjari | 2 | 1 | 5 | 1 | - | 1 | - | 3 | 9 | 2 | 9 | 1 | 9 | 3 | 1 | 7 | 5 | 1 | 3 | 5 | 4 | 9 | 5 | 1 | 3 | 1 | 5 | 9 |
| Vishnubhog-I | 2 | 1 | 5 | 1 | - | 1 | - | 1 | 9 | 1 | 9 | 1 | 9 | 3 | 1 | 3 | 7 | 1 | 3 | 7 | 1 | 1 | - | 1 | 3 | 3 | 1 | 1 |
| Vishnubhog-II | 2 | 1 | 5 | 1 | - | 1 | - | 1 | 9 | 1 | 9 | 1 | 9 | 2 | 1 | 5 | 7 | 1 | 3 | 5 | 3 | 1 | - | 1 | 3 | 3 | 1 | 1 |

| | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Anterved | 1 | - | - | 9 | 2 | 9 | 3 | 5 | 1 | 1 | - | 5 | 7 | 5 | 9 | 1 | 9 |
| Atmasheetal | 1 | - | - | 9 | 1 | 1 | 7 | 5 | 7 | 1 | - | 3 | 3 | 5 | 3 | 3 | 9 |
| Badshahbhog | 1 | - | - | 9 | 2 | 3 | 7 | 7 | 5 | 1 | - | 3 | 5 | 5 | 1 | 1 | 9 |
| Bisni | 1 | - | - | 9 | 3 | 1 | 7 | 3 | 3 | 3 | - | 3 | 5 | 5 | 9 | 1 | 9 |
| Chinnor –I | 1 | - | - | 9 | 2 | 3 | 7 | 7 | 5 | 3 | - | 3 | 5 | 5 | 9 | 5 | 9 |
| Chinnor-II | 9 | 1 | 5 | 9 | 3 | 3 | 7 | 7 | 5 | 3 | 7 | 5 | 9 | 5 | 9 | 1 | 9 |
| Dubraj-I | 9 | 1 | 5 | 9 | 3 | 3 | 7 | 3 | 5 | 3 | 7 | 5 | 9 | 5 | 9 | 1 | 9 |
| Dubraj-II | 9 | 1 | 5 | 9 | 3 | 3 | 7 | 3 | 5 | 1 | 7 | 5 | 9 | 5 | 9 | 1 | 9 |

***Table 2 continued...***

***Table 2 continued...***

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dubraj-III | 9 | 1 | 5 | 9 | 3 | 3 | 5 | 3 | 5 | 1 | 7 | 5 | 9 | 5 | 9 | 1 | 9 |
| Dujai | 1 | - | - | 9 | 2 | 3 | 7 | 3 | 5 | 5 | - | 7 | 5 | 7 | 3 | 1 | 9 |
| Elaychi | 9 | 4 | 5 | 9 | 2 | 7 | 5 | 5 | 3 | 9 | 7 | 5 | 5 | 7 | 9 | 3 | 9 |
| Gopalbhog | 9 | 8 | 1 | 9 | 1 | 1 | 5 | 7 | 5 | 3 | 3 | 7 | 9 | 5 | 9 | 1 | 9 |
| Gangabaru | 1 | - | - | 9 | 1 | 3 | 5 | 7 | 5 | 5 | - | 3 | 5 | 7 | 9 | 1 | 9 |
| Jaigundi | 1 | - | - | 9 | 2 | 5 | 7 | 7 | 5 | 1 | - | 3 | 5 | 5 | 9 | 1 | 9 |
| Javaphool | 1 | - | - | 9 | 3 | 9 | 7 | 5 | 5 | 3 | - | 5 | 7 | 3 | 9 | 1 | 9 |
| Jeeradhan | 9 | 8 | 1 | 9 | 2 | 1 | 7 | 7 | 3 | 7 | 3 | 5 | 7 | 5 | 5 | 5 | 9 |
| Jeeraphool | 1 | - | - | 9 | 2 | 1 | 7 | 7 | 5 | 5 | - | 3 | 5 | 5 | 1 | 3 | 9 |
| Jaophool | 1 | - | - | 9 | 2 | 1 | 7 | 5 | 5 | 1 | - | 3 | 7 | 3 | 5 | 1 | 9 |
| Kalikamod | 1 | - | - | 9 | 1 | 3 | 7 | 7 | 5 | 5 | - | 1 | 7 | 5 | 1 | 3 | 9 |
| Kapoorsar | 9 | 1 | 5 | 9 | 1 | 1 | 7 | 7 | 3 | 9 | 7 | 7 | 9 | 5 | 5 | 3 | 9 |
| Kasturi | 9 | 1 | 5 | 9 | 2 | 9 | 5 | 3 | 7 | 3 | 5 | 7 | 9 | 5 | 5 | 5 | 9 |
| Kharigilas | 1 | - | - | 9 | 2 | 3 | 7 | 7 | 5 | 5 | - | 9 | 9 | 7 | 9 | 3 | 9 |
| Katarnibhog | 1 | - | - | 9 | 1 | 3 | 5 | 7 | 5 | 1 | - | 3 | 7 | 3 | 3 | 1 | 9 |
| Kheraghul | 1 | - | - | 9 | 2 | 1 | 1 | 5 | 5 | 3 | - | 1 | 3 | 5 | 9 | 5 | 9 |
| Kubrimohar-I | 1 | - | - | 9 | 2 | 3 | 7 | 5 | 5 | 1 | - | 7 | 9 | 5 | 9 | 1 | 9 |
| Kubrimohar-II | 1 | - | - | 9 | 1 | 5 | 7 | 5 | 5 | 5 | - | 5 | 7 | 5 | 7 | 3 | 9 |
| Lalloo-14 | 1 | - | - | 9 | 1 | 7 | 5 | 5 | 1 | 3 | - | 5 | 7 | 5 | 3 | 1 | 9 |
| Londhi | 1 | - | - | 9 | 1 | 7 | 7 | 3 | 3 | 3 | - | 3 | 5 | 5 | 9 | 1 | 9 |
| Mai Dubraj | 9 | 1 | 5 | 9 | 3 | 1 | 7 | 1 | 5 | 1 | 7 | 9 | 9 | 5 | 9 | 3 | 9 |
| Samudrafan | 1 | - | - | 9 | 3 | 7 | 7 | 7 | 3 | 5 | - | 3 | 5 | 5 | 1 | 5 | 9 |
| Shyamjeera | 1 | - | - | 9 | 2 | 3 | 7 | 7 | 7 | 3 | - | 3 | 5 | 5 | 9 | 3 | 9 |
| Srikamal | 1 | - | - | 9 | 2 | 3 | 5 | 7 | 5 | 3 | - | 5 | 5 | 7 | 1 | 3 | 9 |
| Sukalaphool | 9 | 8 | 5 | 9 | 1 | 1 | 3 | 7 | 5 | 3 | 5 | 5 | 9 | 5 | 5 | 1 | 9 |
| Tilkasturi | 1 | - | - | 9 | 1 | 3 | 3 | 5 | 5 | 3 | - | 5 | 5 | 5 | 5 | 1 | 9 |
| Tulasiprasad | 9 | 8 | 5 | 9 | 2 | 1 | 3 | 7 | 5 | 9 | 3 | 3 | 9 | 5 | 3 | 3 | 9 |
| Tulsimanjari | 1 | - | - | 9 | 1 | 1 | 7 | 7 | 5 | 5 | - | 3 | 7 | 5 | 9 | 1 | 9 |
| Vishnubhog-I | 1 | - | - | 9 | 3 | 3 | 7 | 5 | 5 | 3 | - | 3 | 5 | 5 | 3 | 3 | 9 |
| Vishnubhog-II | 1 | - | - | 9 | 3 | 5 | 7 | 5 | 5 | 3 | - | 3 | 5 | 3 | 3 | 5 | 9 |

(Sarawgi and Bisne, 2006). The landraces used in this study showed very huge potential for improvement with good yield level; hence after purification and identification of elite genotype they can be released as a variety.

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