**Improvement of Traditional Local Rice Varieties through Induced Mutations using Gamma Radiations**

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**Abstract**

Two aromatic popular traditional local rice varieties *viz*., Dubraj and Jawaphool were undertaken to improve undesirable characters *viz.*, tall plant height and very late maturity duration using 250 and 300Gy doses of γ-rays. Frequency of viable mutations and mutations with economic importance characters varies with treatment as well as genotypes. Radiation dose 300 Gy was found to be most desirable to inducing viable mutations in both genotypes. Frequency of viable mutants was observed more in Dubraj variety as compare to Jawaphool. Twenty three types of viable mutants 18 from Dubraj and 5 from Jawaphool were observed in M2 generation. These Dubraj mutants were further advanced and classified into 11 (semi-dwarf and mid late maturity), 07 (dwarf, early maturity and increased tillering with high yielding), 2(bushy and broad leaf), 1(grassy leaf), 1 (cytoplasmic male sterile type) and 1(clustered grain) in Dubraj and in Jawaphool 4 were (Semi tall and mid-late maturity) and one was (tall, clustered grain with red kernel colour). In Dubraj 42-50% reduction in plant height was observed as compared with its parent variety. Isolation of three dwarf and semi- dwarf mutants coupled with earliness in Dubraj and 3 semi-tall and mid-late maturing mutants in Jawaphool have assumed great significance in improving traditional aromatic short/medium grain rices.

**Key Words** - Induced mutation, Gamma rays, Traditional aromatic rice, Dubraj, Jawaphool

**I. Introduction**

Rice is the stable food crop of millions of mankind from the dawn of civilization. It is consumed by half of the world’s population and cultivated in more than 100 countries in every continent except America. Asia alone produces over 95% of global rice with China (194.3mt) and India (148.3 mt), ranked first and second producing half of the world’s rice (Upadhyay et al., 2011). Chhattisgarh state of India is known as bowl of rice. This state is very popular for short /medium slender aromatic rices viz. Dubraj, Badshahbhog, Vishnubhog, Gopalbhog, Kubrimohar, Tulshi Manjari, Laxmibhog, Jawaphool etc. More than 100 traditional land races of aromatic rice with pleasant aroma with excellent cooking and eating quality are grown in different part of the state. These varieties are very tall (>160cm) stature and having very late maturity (>150 days). Due to tall stature they are prone to lodging whereas late maturing varieties required more fertilizer, less response to the applied inputs and require more irrigation (Sharma et al., 2017). Chances of pest attacks are more in late maturity varieties. Hence, there is need to improve the yield potential of such cultivars by reducing the plant height and increasing nitrogen responsiveness without losing the aroma, grain texture and other quality characters of the parental variety or without losing its original quality features. Since, mutagenesis has proved very effective in reducing plant height (Balotch et al., 2003; Chakravarty, 2010). The present work has been carried out by in traditional local rice varieties using nuclear techniques.

**II. Material and Methods**

Two traditional aromatic rice varieties, Dubraj (medium slender fine grain) and Jawaphool (short slender grain) were selected for this study. Total 1000 seeds of each variety were treated with 250Gy and 300Gy dose of gamma rays (in two sets) at Bhabha Atomic Research Center, Trombey, Mumbai during 2013 and M1 population were raised at Research cum Instructional Farm, IGKV, Raipur, C.G., India during *Rabi season* 2013. Total 454 main panicle from single plant from Dubraj and 398 palnts from Jawaphool were selected from M1 population and were grown in rows. M2 population plants were raised during *Kharif* 2014. Forty two plants with desirable traits (semi dwarf and early maturity) of Dubraj and 27 plants of Jawaphool were initially selected in M2 during *Rabi* 2014. Later on total 18 mutants from Dubraj and 05 mutants from Jawaphool were selected in M3 population for further advancement and selected progenies were raised as M4 population during *Kharif* 2015. Plants from M4 population were completely homozygous and synchronized. Selected progenies from M4 generation were raised in M5 generation during Rabi 2015 for seed multiplication. Finally in M6-M7 generation 7 mutants from Dubraj and 4 mutants from Jawaphool were selected on the basis of yield performance for multilocation yield trials.

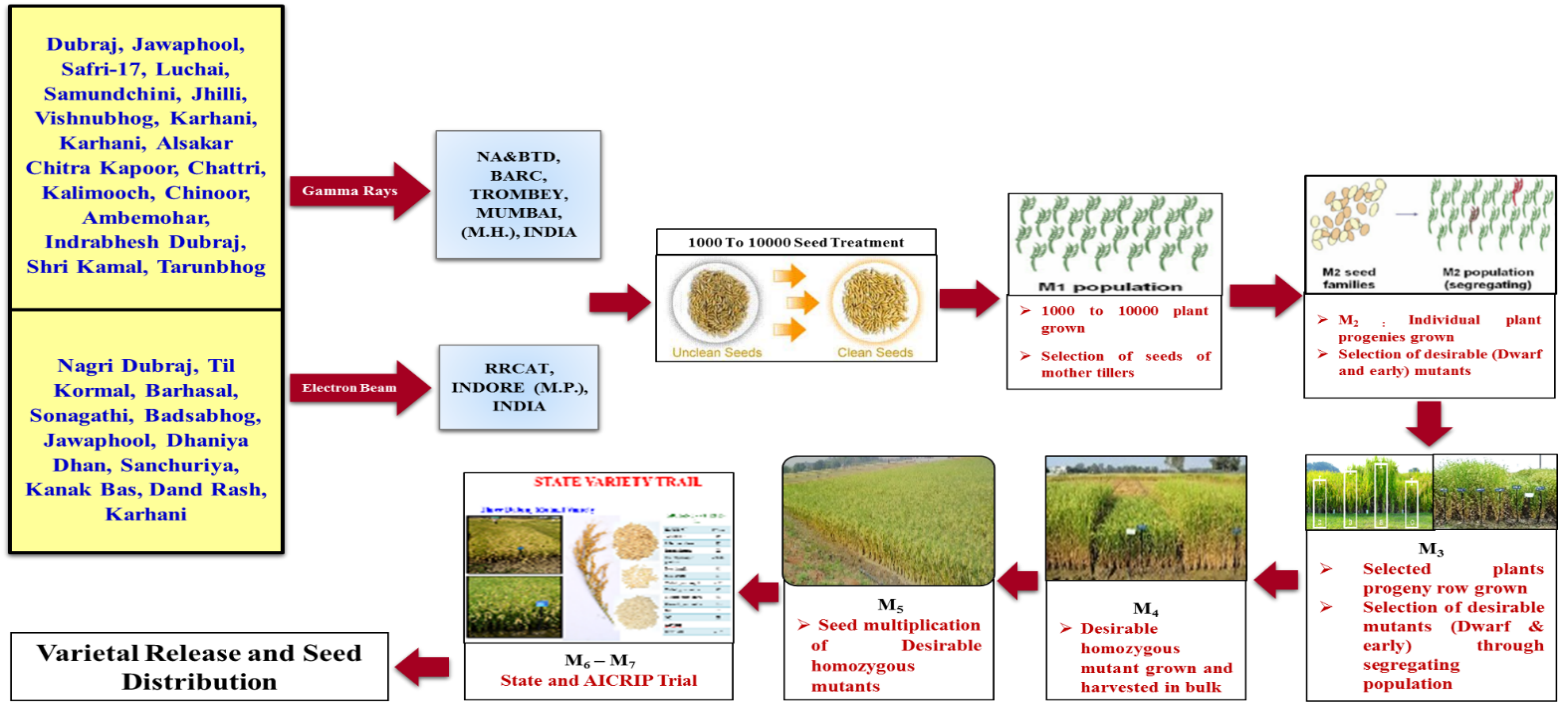


Figure 1: Methodology for developing mutants in Rice

**III. Result and Discussion**

Frequency of wide range of viable mutations was observed from the present study (Table 1). Eighteen mutants in Dubraj and 05 mutants in Jawaphool (Plate 1&2) were selected in early generations. Mutants with semi-dwarf stature, dwarf stature, early maturing, increased tillering, bushy stature, grassy leaves, high grain yield and other desirable traits were found. The differences observed in the spectra of morphological mutations were more of quantitative nature rather than qualitative. High frequency of semi-dwarf and dwarf viable mutants was observed in the present study. Several workers also found high frequency of mutants for plant height in rice (Shadakshari et al., 2001; Singh and Singh, 2003; Sharma et al., 2008).

Dubraj and Jawaphool are very good in cooking quality and aroma, but these possess two detrimental aspects, which are tall stature (>155cm) habit with weak straw and late maturity (>150 days). Both these attributes make the cultivar incapable of responding to high fertility or withstanding lodging. In such situation, isolation of medium to mid-late maturing, semi-dwarf, dwarf mutants and others desirable mutants have assumed great significance. Out of 18 mutants 07 mutants were found dwarf plant height showing 40 to 42% reduction of plant height (Graph 1) .Eleven semi- dwarf mutants with plant height less than 125 cm as compared to control (>155 cm) were isolated from Dubraj and 4 from Jawaphool having mid/mid-late maturity 135-145 days as compared to parent (>150 days) and semi-tall plant height( 125-135 cm as compare to parent having 150cm plant height) were isolated (Graph 1) several workers also reported early maturing mutants in rice after mutagen treatments (Shadakshari et al., 2001; Singh and Singh, 2003; Domigo et al., 2007). It was found that 300Gy dose of gamma rays was desirable because most of viable dwarf mutants were observed with this dose. A total of 7 dwarf mutants showed increased tillering capacity (12-14 tiller per plants) which was 20 to 25 % higher than the parent (8-10 tillers per plants) (Graph 1). Rashid et al., 2003; Maity et al., 2005 and Domingo et al., 2007 reported similar results for such mutants in rice after mutagenic treatments. These dwarf and high tillering mutants had 248 grain per panicles which was 25-30 % superior then the parents (182).

Mutants for other characters viz. 01 grassy mutant having very narrow leaf, bushy and broad leaf nature (02 mutants) were also observed in Dubraj. Bushy mutant was also reported in rice by Agrawal et al. (2000); Singh and Singh (2003); Domingo et al (2007) and narrow leaf mutant was also reported in rice by Singh et al., 1998; Singh and Singh (2003). Most of the mutants showing no change in the length and breadth of grains were also observed. Dubraj grassy mutant grain size was reduced by 10 – 15%. In earlier studies reduced grain size mutant was found by Shobharani et al. (2004).

One mutant showed high spikelet sterility (>95%) offering the scope for development of Cytoplasmic Male Sterile line (CMS line) in back ground of Dubraj. Complete sterile mutants in rice after mutagenic treatment were also reported by Luo and Zhang (1998), Shadakshari et al. (2001) and Singh (2003). It was also observed that incorporation of other desirable traits *viz.,* hightiller number, high number of fertile spikelet’s in per panicle besides dwarf plant heightin Dubraj mutants are due to pleiotropy occurs when one gene influences two or more seemingly unrelated phenotypic traits.

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Figure 2: Mutant plant of Dubraj variety (a) Dwarf plant (b) semi tall plant (c) Dwarf and high tillering mutant (d) Sterile mutant (e) Grassy mutant (f) Bushy mutant

**Plant height 40-42% reduced Days to maturity 05-10% reduced**

**No of tillers 20-25% increases No of seeds per panicles increase 25-30%**

Graph 1: Dubraj Dwarf mutant compression with parent.

In Jawaphool total 05 semi-tall mutants showed increased tillering capacity (8-10 tiller per plants) which was 20 to 25 % higher than the parent (6-8 tillers per plants) (Graph 1). These semi-tall and mid-late maturing mutants had 340 grain per panicles which was 30-32 % superior then the parents (260). Many workers reported high yielding mutants in rice after mutagenic treatments (Shadakshari et al., 2001; Singh and Singh, 2003; Domingo et al., 2007; Bughio et al. 2007).

Further good quality and high yield mutants were selected from M4 generation lead to M5 and M6 generation. Upon reaching M6 generation, three (03) desirable mutants (dwarf and early) in Dubraj and four (04) desirable mutants (semi tall and early) in Jawaphool were selected for multilocation yield trials.

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Figure 3: Jawaphool mutants (a) Semi tall and mid late (b) Clustered grain

Among the three desirable Dubraj mutants one i.e. Trombay Chhattisgarh Dubraj Mutant-1 ( TCDM-1) was released by state varietal release committee (SVRC) as first dwarf and aromatic rice mutant of Dubraj with similar grain quality for marking a great achievement for the marginal farmers of Chhattisgarh State of India.

**Table 1:** Different Morphological Observations of Both Genotypes

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S.NO.** | **Mutants** | **Leaf Color** | **Stem Thickness** | **Plant Height cm.** | **Days To Maturity** | **Total Tillers Per Plant** | **Effective Tillers Per Plant** | **Panicle Length** | **Per Panicle Seed (Filled/Unfilled)** | **Plant Habits** | **BLB** |
| **NORMAL DUBRAJ** | | | | | | | | | | | |
| **A.** | **Normal plant** | **LG** | **M** | **>155** | **>150** | **<10** | **<8** | **25** | **182/22** | **Tall** | **T** |
| **DWARF MUTANT DUBRAJ** | | | | | | | | | | | |
| 1 | Mutant-1 | DG | Thick | 98 | 148 | 12 | 10 | 23 | 235/12 | Dwarf | T |
| 2 | Mutant-3 | DG | Thick | 95 | 140 | 12 | 10 | 24 | 240/18 | Dwarf | T |
| 3 | Mutant-9 | DG | Thick | 98 | 145 | 12 | 10 | 23 | 232/14 | Dwarf | T |
| 4 | Mutant-13 | DG | Thick | 82 | 142 | 12 | 12 | 24 | 243/16 | Dwarf | R |
| 5 | Mutant-14 | DG | Thick | 83 | 140 | 14 | 12 | 24 | 248/18 | Dwarf | R |
| 6 | Mutant-192 | Green | Thin | 87 | 128 | 10 | 8 | 21 | 151/45 | Dwarf | T |
| 7 | Mutant-453 | DG | Thick | 99 | 138 | 16 | 14 | 25 | 252/13 | Dwarf | T |
| **SEMI-TALL MUTANT DUBRAJ** | | | | | | | | | | | |
| 8 | Mutant-2 | LG | M | 128 | 138 | 12 | 11 | 20 | 192/20 | ST | T |
| 9 | Mutant-42 | LG | M | 122 | 148 | 10 | 8 | 21 | 168/39 | ST | R |
| 10 | Mutant-43 | LG | M | 132 | 150 | 15 | 12 | 24 | 244/35 | ST | T |
| 11 | Mutant-45 | LG | M | 138 | 145 | 14 | 10 | 22 | 210/29 | ST | T |
| 12 | Mutant-51 | LG | M | 134 | 145 | 14 | 12 | 24 | 243/12 | ST | T |
| 13 | Mutant-73 | LG | M | 122 | 128 | 11 | 11 | 22 | 175/54 | ST | T |
| 14 | Mutant-173 | LG | M | 125 | 130 | 10 | 10 | 19 | 155/44 | ST | T |
| **DWARF BUSHY MUTANT DUBRAJ** | | | | | | | | | | | |
| 15 | Mutant-295 | LG | M | 86 | 128 | 16 | 14 | 22 | 105/109 | D(**Bushy**) | T |
| 16 | Mutant-433 | DG | Thick | 88 | 134 | 20 | 20 | 23 | 170/22 | D(**Bushy**) | R |
| **DWARF GRASSY MUTANT DUBRAJ** | | | | | | | | | | | |
| 17 | Mutant-380 | Green | V. Thin | 98 | 130 | 78 | 55 | 15 | 72/18 | D (**Grassy**) | R |
| **SEMI-TALL STERILE MUTANT DUBRAJ** | | | | | | | | | | | |
| 18 | Mutant-47 | LG | M | 136 | 131 | 17 | 17 | 21 | CMS | ST | T |
| **NORMAL JAWAPHOOL** | | | | | | | | | | | |
| **B.** | **Normal** | **LG** | **M** | **>155** | **>150** | **<8** | **<8** | **29** | **260/28** | **Tall** | **S** |
| **SEMI-TALL MUTANT JAWAPHOOL** | | | | | | | | | | | |
| 19 | Mutant-17 | LG | M | 118 | 138 | 12 | 11 | 29 | 270/25 | ST | T |
| 20 | Mutant-18 | LG | M | 120 | 135 | 13 | 11 | 30 | 265/28 | ST | T |
| 21 | Mutant-31 | LG | M | 118 | 130 | 14 | 12 | 30 | 340/23 | ST | T |
| 22 | Mutant-53 | LG | M | 139 | 140 | 14 | 13 | 28 | 280/19 | ST | T |
| **TALL MUTANT JAWAPHOOL WITH CLUSTERED GRAIN** | | | | | | | | | | | |
| 23 | Mutant-56 | LG | Thick | 182 | 150 | 12 | 11 | 36 | 370/21 | Tall | T |

**BLB**- Bacterial Leaf Bligh **LG**- Light Green **R**- resistance **T**- Tolerance **DG**- Dark Green **M**- Medium **D**- Dwarf **ST**- Semi Tall

**IV. Conclusion**

In the present study mutation breeding is used as an effective tool to develop dwarf and early maturing Dubraj and Jawaphool variety without losing their original quality features. This method is very useful to remove one or two defects of traditional local rice varieties. This is one of the simple and less expensive techniques to improve local varieties of rice as per the need of farmers.

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