# Development and characterization of genetic variants in bread wheat for plant architecture, grain texture and grain quality attributes

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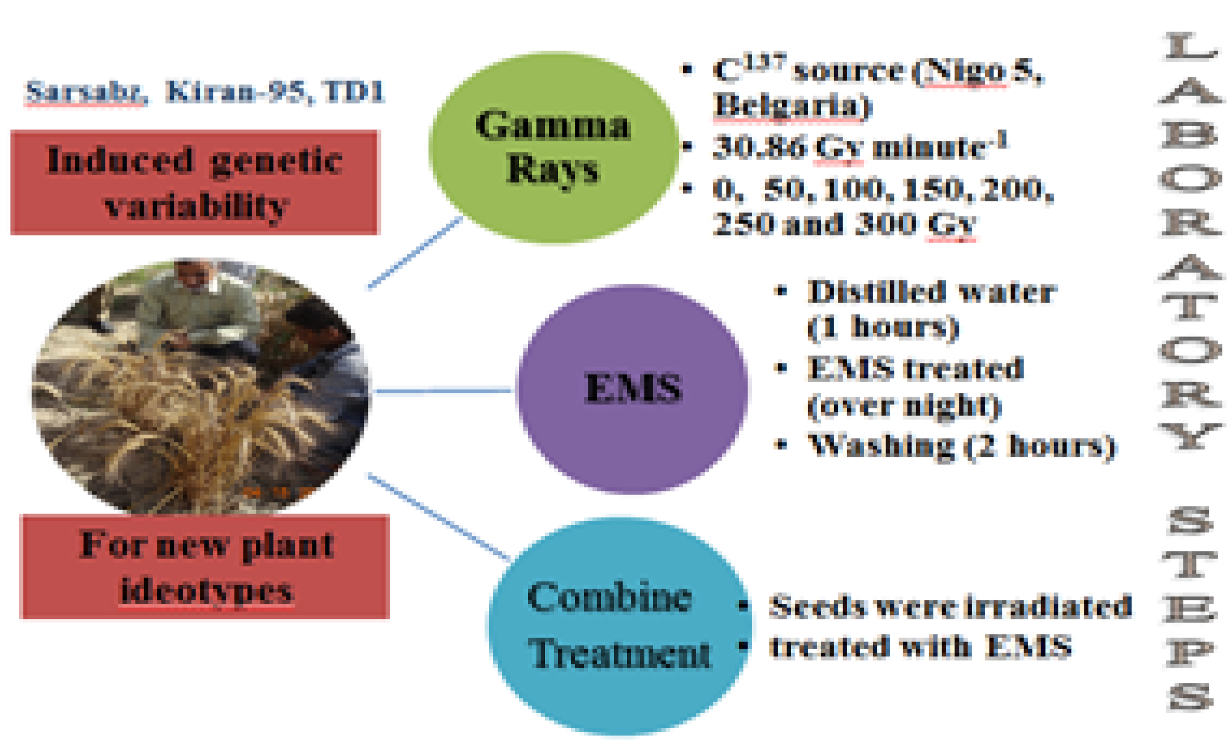
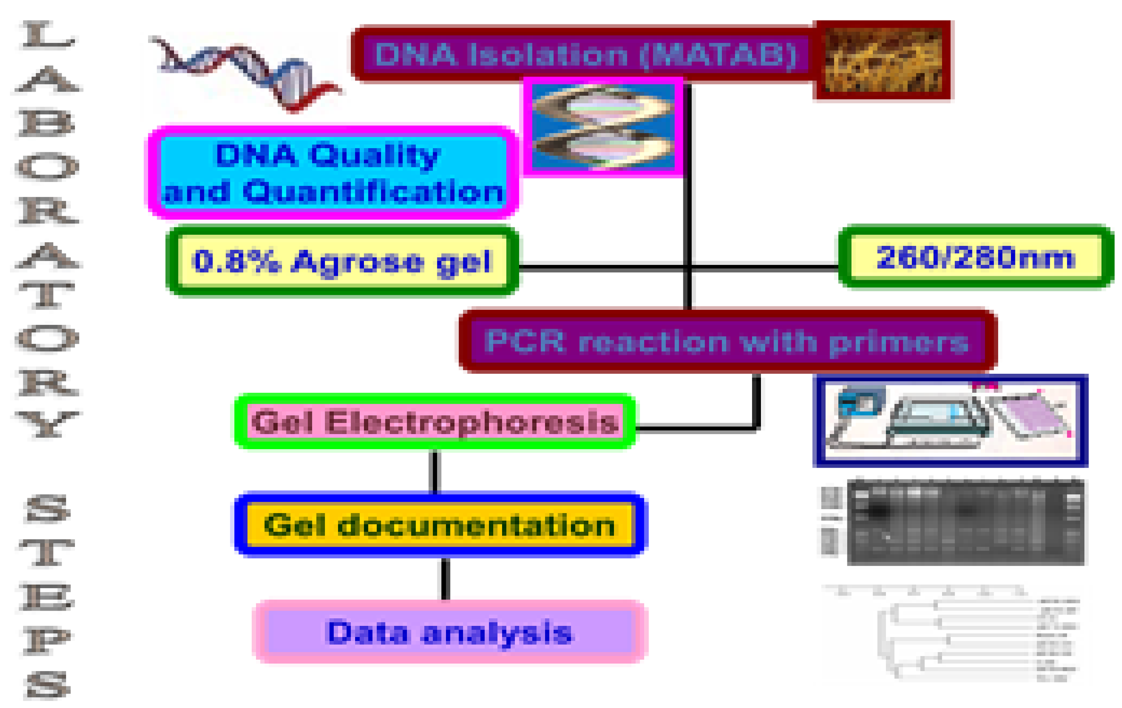
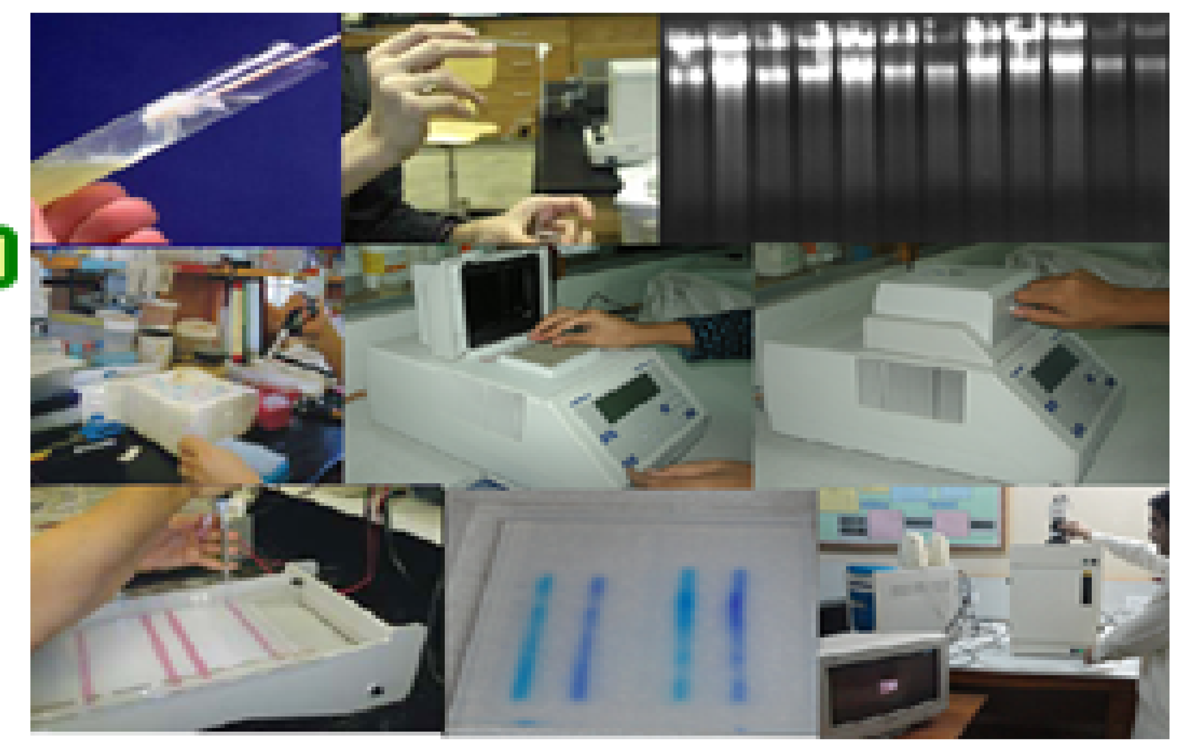
**ABSTRACT** Wheat is the most important cereal crop of Pakistan which contributes 10% to the value added in agriculture and 2% to GDP. The objective of this study was to broaden the genetic bases through identification and evaluation of promising wheat mutants with higher yield and better quality. Genetic variability was induced in three wheat varieties Sarsabz, Kiran-95 and TD1 for the development of new ideotypes by gamma rays, EMS and combined treatment. From $M_3$ generation, 30 promising mutants were selected on the basis of phenotypic variations. These mutants were confirmed through SSR markers in $M_4$ generation and further characterized for quality traits through PINa-D1, PINb-D1 and waxy gene. As the physical trait grain texture affects the milling and marketing of bread wheat, the mutants were characterized based on their hardness. Among the 30 mutants along with three parents, the grain texture of 20 mutants was categorized as soft, 12 as hard and only one mutant was classified as ultra-hard. Our results showed five types of waxy phenotype (Type 1, 2, 3, 5 and 8) in which five mutants were non-waxy, three were waxy and 19 along with parents were partial waxy. Hardness index was ranged between 56 to 89 indexes. Seed diameter was varied from 2.51 to 2.86 and moisture contents were between 10.13 to 11.70. Highest gluten contents 45 were found in L23 and lowest were found in L8 and L11 (37). Maximum zeleny value of 87.3 was recorded in L12 and 23. Maximum falling number was observed in L5 (729 seconds) and minimum was 425 seconds in mutant L23. In this work new bread wheat ideotypes were developed for the identification of plant architecture and grain quality traits which could play a role in future wheat breeding. This work reports genetic characteristics of grain texture and starch content at gene level that could help in the improvement of modern cultivars for the purpose of milling and value addition to wheat product.

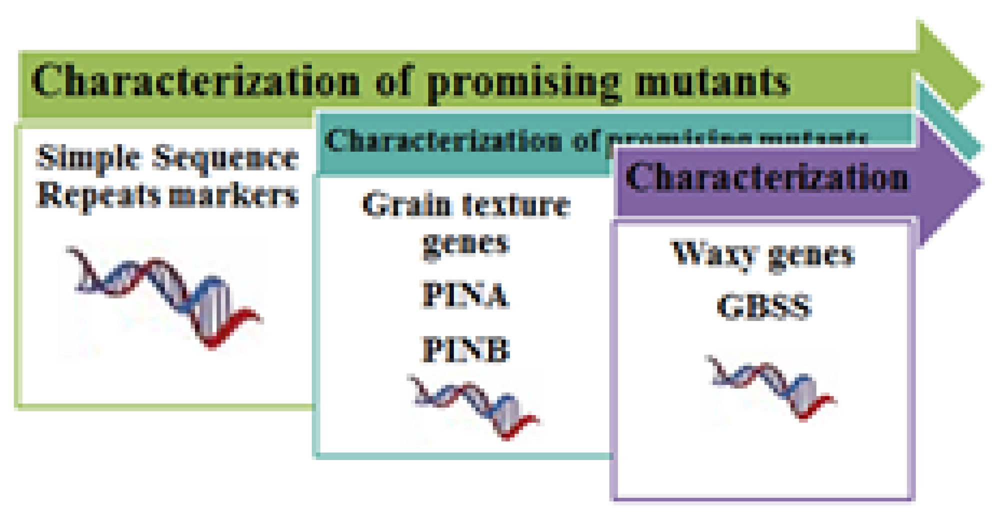
## MATERIAL & METHODS



**DNA Extraction and gene specific marker analysis:** Isolation of pure DNA is pre-requisite for the molecular marker studies. Fresh young leaves were collected from field at seedling stage from thirty mutants and isolated the DNA by using MATAB method (Bibi et al. 2010) DNA stock of each mutant kept in refrigerator at -20$^0$C. The extracted DNA was quantified as method described by Bibi *et al.* 2012.




According to the guidelines outlined in AACC (1990), each wheat mutant was evaluated for total protein percentage, moisture content, gluten content, falling number, and Zzeleny (sedimentation value). Protein was also assessed using a grain analyzer. Wheat samples were ground using a laboratory mill 3100 Perton in accordance with the recommended procedure (AACC, 1990).

## RESULTS

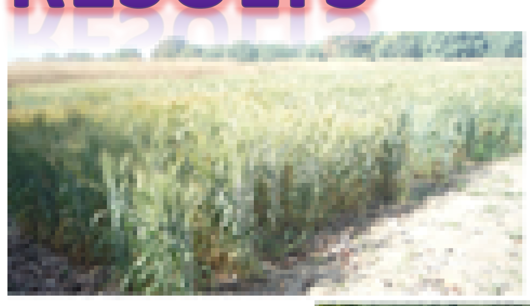


Figure 4-7 Field view of $M_2$ generation (Rabi 2012-13).

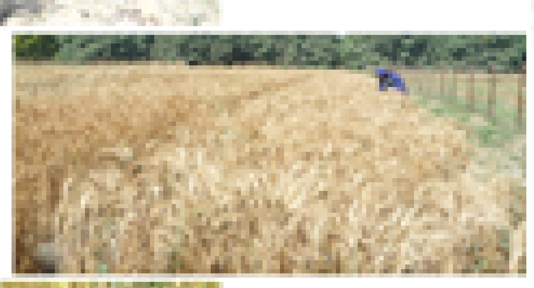


Figure 4-10 Wheat crop at maturity in $M_2$ generation (Rabi 2012-13) at NIA Farm.

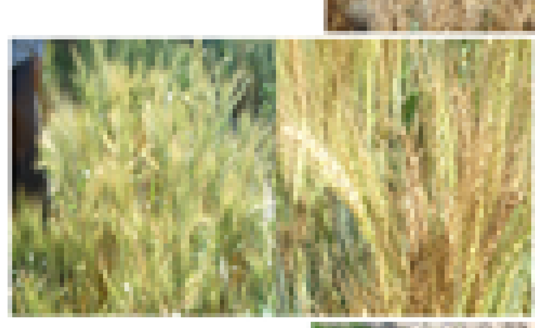


Figure 4-9 Early mature mutant observed at $M_2$ generation (Rabi 2012-13).

Figure 4-8 Dark green and broad leaf mutant observed in M2 generation (Rabi 2012-13).

Figure 4-13 phenotypic variation in spikes morphology

Figure 4-11 Genetic variability at maturity in $M_2$ generation (Rabi 2012-13) at NIA Farm

Figure 4-12 Identified a short stature mutant without pleiotropic effect in $M_2$ generation

Figure 4-16 (.xxx, SE4/12-1, SE4/12-1, SE4/12-3, SE4/12-4, SE4/12-5, SE4/12-6, SE5/12-7, SE5/12-8, SE5/12-9, SE5/12-10, TCT4/12-1, TCT4/12-2, SE5/12-12, SE5/12-13, SE5/12-15, SE5/12-17, SE5/12-19, SG3/12-20, SG3/12-21, SG3/12-23, SG3/12-25, SG2/12-26, SG2/12-27, SE2/12-29, SG4/12-35, SG1/12-38, SG1/12-41, SG1/12-43, KCT7/12-44, SCT6/9, P= Parent

| S.No. | Mutant | Moisture | Diameter | Hardness Index | Gluten | Zeleny | FN(Sec) |
|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | 2.80 | 83.0 | 38.0$^{DE}$ | 85.0$^{AB}$ | 588.0$^{EF}$ |
| [illegible] | [illegible] | [illegible] | 2.77 | 89 | 39.0$^{CDE}$ | 85.3$^{AB}$ | 575.0$^{GHIJ}$ |
| [illegible] | [illegible] | [illegible] | 2.77 | 82 | 37.3$^{E}$ | 85.0$^{AB}$ | 554.0$^{LM}$ |
| [illegible] | [illegible] | [illegible] | 2.73 | 82 | 38.0$^{DE}$ | 86.0$^{AB}$ | 516.0$^{O}$ |
| [illegible] | [illegible] | [illegible] | 2.86 | 82 | 38.0$^{DE}$ | 85.3$^{AB}$ | 729.0$^{A}$ |
| [illegible] | [illegible] | [illegible] | 2.81 | 79 | 38.0$^{DE}$ | 84.0$^{AB}$ | 624.0$^{CD}$ |
| [illegible] | [illegible] | [illegible] | 2.81 | 88 | 38.0$^{DE}$ | 86.3$^{AB}$ | 562.0$^{KL}$ |
| [illegible] | [illegible] | [illegible] | 2.72 | 84 | 41.0$^{BCD}$ | 86.3$^{AB}$ | 520.0$^{NO}$ |
| [illegible] | [illegible] | [illegible] | 2.80 | 78 | 38.0$^{DE}$ | 85.0$^{AB}$ | 516.0$^{O}$ |
| [illegible] | [illegible] | [illegible] | 2.69 | 84 | 40.3$^{CDE}$ | 84.0$^{AB}$ | 561.0$^{KL}$ |
| [illegible] | TCT4/12-1 | [illegible] | 2.72 | 70 | 37.3$^{E}$ | 84.3$^{AB}$ | 498.0$^{P}$ |
| [illegible] | TCT4/12-2 | [illegible] | 2.82 | 79 | 44.0$^{AB}$ | 87.0$^{A}$ | 569.0$^{IJK}$ |
| [illegible] | [illegible] | [illegible] | 2.78 | 77 | 39.3$^{CDE}$ | 86.3$^{AB}$ | 568.0$^{KL}$ |
| [illegible] | [illegible] | [illegible] | 2.80 | [illegible] | 40.0$^{CDE}$ | 86.0$^{AB}$ | 614.0$^{D}$ |
| [illegible] | [illegible] | [illegible] | 2.67 | [illegible] | 38.0$^{DE}$ | 85.0$^{AB}$ | 575.0$^{GHIJ}$ |
| [illegible] | [illegible] | [illegible] | 2.87 | [illegible] | 39.0$^{CDE}$ | 84.0$^{AB}$ | 541.0$^{NO}$ |
| [illegible] | [illegible] | [illegible] | 2.61 | 89 | 40.0$^{CDE}$ | 86.3$^{AB}$ | 671.0$^{B}$ |
| [illegible] | [illegible] | [illegible] | 2.68 | [illegible] | 37.0$^{E}$ | 84.0$^{AB}$ | 572.0$^{HIJK}$ |
| [illegible] | [illegible] | [illegible] | 2.64 | [illegible] | 40.3$^{CDE}$ | 86.3$^{AB}$ | 473.0$^{Q}$ |
| [illegible] | [illegible] | [illegible] | 2.78 | 76 | 42.3$^{ABC}$ | 86.0$_{AB}$ | 717.0$^{A}$ |
| [illegible] | [illegible] | [illegible] | 2.69 | 83 | 41.0$^{BCD}$ | 86.0$^{AB}$ | 581.0$^{FGHI}$ |
| [illegible] | [illegible] | [illegible] | 2.87 | 88 | 42.0$^{ABC}$ | 86.3$^{AB}$ | 597.0$^{E}$ |
| [illegible] | [illegible] | [illegible] | 2.78 | 77 | 45.0$^{A}$ | 87.3$^{A}$ | 425.0$^{T}$ |
| [illegible] | [illegible] | [illegible] | 2.72 | 78 | 42.0$^{ABC}$ | 85.3$^{AB}$ | 532.0$^{OP}$ |
| [illegible] | [illegible] | [illegible] | 2.76 | 81 | 39.0$^{CDE}$ | 84.0$^{AB}$ | 627.0$^{C}$ |
| [illegible] | [illegible] | [illegible] | [illegible] | 81 | 39.7$^{CDE}$ | 86.3$^{AB}$ | 527.0$^{NO}$ |
| [illegible] | [illegible] | [illegible] | 2.66 | 76 | 39.0$^{CDE}$ | 84.0$^{AB}$ | 563.0$^{JKL}$ |
| [illegible] | [illegible] | [illegible] | 2.69 | 83 | 38.0$^{DE}$ | 84.0$^{AB}$ | 572.0$^{HIJK}$ |
| [illegible] | [illegible] | [illegible] | 2.76 | 78 | 39.3$^{CDE}$ | 84.0$^{AB}$ | 585.0$^{[illegible]}$ |
| [illegible] | [illegible] | [illegible] | 2.72 | 88 | 37.3$^{E}$ | 83.3$^{AB}$ | 545.0$^{MN}$ |
| [illegible] | Sarsabz | [illegible] | 2.81 | 76 | 39.3$^{CDE}$ | 85.0$^{AB}$ | 547.0$^{MN}$ |
| [illegible] | Kiran-95 | [illegible] | 2.68 | 64 | 45.0$^{A}$ | 86.0$^{AB}$ | 584.0$^{FGH}$ |
| [illegible] | TD1 | [illegible] | [illegible] | 82 | 38.3$^{DE}$ | 82.3$^{B}$ | 542.0$^{MNO}$ |
| 34. | [illegible] | [illegible] | 2.86 | 73 | 39.636 | 85.202 | 568.55 |

**CONCLUSION:** Thirty new wheat ideotypes have been generated through mutation breeding. According to results, five types of waxy phenotype i.e. Type1, 2, 3, 5 and 8 were observed in which five mutants were non-waxy, three were waxy mutant and nineteen mutants along with parents were partial waxy mutants.

## REFERENCES

*Bibi Sajida, M. Umar Dahot, Ghullam. Shah. Nizamani, Imtiaz A. Khan, A. Khatri, M. H. Naqvi, F.C. Oad and U.A. Burio, "Molecular marker assisted selection for drought tolerant wheat genotype," Pakistan Journal of Botany, Vol. 42, Issue 4, ppt. 2443-2452, 2010.*

*Bibi, Sajida. and Arshad, Rubina, "Molecular Characterization of Genetic Variants in Bread Wheat through SSR Markers". International Journal of Agriculture and Biology, Vol. 24, Issue 5, ppt.1371-1375, 2020.*