**Wheat Gene Catalogue – Trait Summary**

1. **Morphological and Physiological Traits**

**1.1 Gross Morphology: Spike characteristics**

**1.1.1. Squarehead/spelt**

**1.1.2. Club/Compact spike**

**1.1.3. Sphaerococcum**

**1.2. Branched spike**

**1.3. Elongated glume**

**1.4. Ear length**

**1.5. Multi-gynoecium; Multi-ovary**

**1.6. Accumulation of abscisic acid**

**1.7. Alkylresocinol content in grain**

**1.8. Aluminium tolerance**

**1.9. Anthocyanin pigmentation**

**1.9.1. Purple anthers**

**1.9.2. Purple/Red auricles. Purple leaf base/sheath**

**1.9.3. Red/purple coleoptiles**

**1.9.4. Purple/red culm/straw/stem**

**1.9.5. Purple grain/pericarp**

**1.9.6. Purple glume**

**1.9.7 Purple leaf blade**

**1.10 Awnedness**

**1.10.1. Dominant inhibitors of awns**

**1.10.2. Promotors of awns**

**1.10.3. Smooth awns**

**1.11. Basal Sterility in speltoids**

**1.12. Blue aleurone**

**1.13. Brittle culm**

**1.14 Brittle rachis**

**1.15. Boron tolerance**

**1.16. Cadmium uptake**

**1.17. Chlorophyll abnormalities**

**1.17.1. Virescent**

**1.17.2. Chlorina**

**1.17.3. Striato-virescens**

**1.17.4. Yellow-green**

**1.18. Cleistogamous flowering**

**1.19. Copper efficiency**

**1.20. Corroded**

**1.21. Crossability with rye and *Hordeum* and *Aegilops* spp**

**1.21.1. Common wheat**

**1.21.2. Tetraploid wheat**

**1.22. Dormancy (Seed)**

**1.22.1. Germination index**

**1.22.2. Vivipary**

**1.22.3. Pre-harvest sprouting**

**1.23. Ear emergence**

**1.24. Earliness *per se***

**1.25. Embryo lethality**

**1.24.1. Embryo lethality in wheat × rye hybrids**

**1.26. Flag leaf width**

**1.27. Flowering time**

**1.28. Flour colour**

**1.29. Free-threshing habit**

**1.30. Frost resistance**

**1.31. Gametocidal genes and segregation distortion**

**1.31.1. Gametocidal activity**

**1.31.2. Suppression of gametocidal genes**

**1.31.3 Segregation distortion**

**1.32. Gibberellic acid response (insensitivity)**

**1.33. Glaucousness (Waxiness/Glossiness)**

**1.33.1. Genes for glaucousness**

**1.33.2. Epistatic inhibitors of glaucousness**

**1.33.3. Leaf glaucousness**

**1.33.4. Spike glaucousness**

**1.34. Glume and awn colour**

**1.34.1. Red (brown/bronze/black) glumes**

**1.34.2. Pseudo-black chaff**

**1.34.3. Black-striped glumes**

**1.34.4. Inhibitor of glume pigment**

**1.34.5. Chocolate chaff**

**1.34.6. Awn colour**

**1.35. Grain hardness/Endosperm texture**

**1.36. Grain quality parameters**

**1.36.1. Sedimentation value**

**1.36.2. Flour, semolina and pasta colour**

**1.36.3. Amylose content**

**1.36.4. Milling yield**

**1.36.5. Alveograph dough strength W**

**1.36.6. Mixograph peak time**

**1.36.7. Starch characteristics**

**1.36.8. Loaf volume**

**1.36.9. Dough rheological properties**

**1.36.10. Grain fructan content**

**1.36.11. Water absorption**

**1.36.12. Chinese dry noodle quality**

**1.36.13. Grain traits based on homolgyREQUIRES REVISION**

**1.37 Grain weight**

**1.38. Grass-clump dwarfness/Grass dwarfness**

**1.39. Growth rate and early vigour**

**1.40. Hairinessy/Pubescence traits**

**1.40.1. Hairy auricles**

**1.40.2. Hairy glumes**

**1.40.3. Hairy leaves**

**1.40.4. Hairy leaf sheath**

**1.40.5. Hairy neck/pubescent peduncle**

**1.40.6. Hairy node/Pubescent node**

**1.41. Heat tolerance**

**1.42. Reduced height**

**1.42.1 Reduced height: GA-insensitive**

**1.42.2. Reduced height: GA-sensitive**

**1.42.3. Reduced height: temporary designations**

**1.42.4. Reduced height: QTL**

**1.43. Herbicide response**

**1.43.1. Difenzoquat insensitivity**

**1.43.2. 2,4-D tolerance**

**1.43.3. Chlortoluron insensitivity**

**1.43.4. Imidazolinone resistance**

**1.44. Hybrid weakness**

**1.44.1. Hybrid necrosis**

**1.44.2. Hybrid chlorosis type 1**

**1.44.3. Hybrid chlorosis type 2**

**1.44.4. Apical lethality**

**1.44.5. Hybrid necrosis type 3**

**1.45. Iron deficiency**

**1.46. Lack of ligules**

**1.47. Leaf characteristics**

**1.47.1. Leaf erectness**

**1.47.2. Leaf tip necrosis**

**1.47.3. Seedling leaf chlorosis**

**1.47.4. Early leaf senescence**

**1.48. Lesion mimicry**

**1.49. Lodging**

**1.50. Male sterility**

**1.50.1. Chromosomal**

**1.50.2. Sterility in hybrids with wheat**

**1.50.3. Photoperiod and/or temperature-sensitive male sterility (PTGMS)**

**1.51. Manganese efficiency**

**1.52. Maturity time**

**1.53. Megasporogenesis**

**1.53.1. Control of megasporogenesis**

**1.54. Meiotic characters**

**1.54.1. Low-temperature pairing**

**1.54.2. Pairing homoeologous**

**1.54.3. Inhibitors of pairing homoeologous**

**1.54.4 Asynapsis/desynapsis**

**1.55. Nitrate reductase activity**

**1.56. Nuclear-cytoplasmic compatability enhancers**

**1.57. Nucleolus organizer regions**

**1.57.1. 18S - 5.8S - 26S rRNA genes**

**1.58. Osmoregulation**

**1.59. Phenol colour reaction of kernels**

**1.60. Pollen killer**

**1.61. Polyphenol oxidase (PPO) activity**

**1.62. Red grain colour**

**1.62.1. Red grain colour**

**1.62.2. Variegated red grain colour**

**1.63. Reaction to black-point of grain**

**1.64. Response to photoperiod**

**1.65. Response to salinity**

**1.65.1. K+/Na+ discrimination**

**1.65.2. Salt tolerance**

**1.65.3. Sodium exclusion**

**1.66. Response to tissue culture**

**1.67. Response to vernalization**

**1.68. Restorers for cytoplasmic male sterility**

**1.68.1. Restorers for *T. timopheevi* cytoplasm**

**1.68.2. Restorers for *Aegilops longissima* cytoplasm**

**1.68.3. Restorers for photoperiod-sensitive *Aegilops crassa* cytoplasm**

**1.68.4 Restorers for temperature-sensitive** *Aegilops kotchyi* cytoplasm

**1.68.5. Restorers for multi-species cytoplasm**

**1.69. Ribosomal RNA**

**1.69. Segregation distortion**

**1.70. Short roots**

**1.71. Soft glumes**

**1.72. Sterol esterification in kernels - Synthesis of b-sitosterol esters**

**1.73. Stem solidness**

**1.74. Temperature-sensitive winter variegation**

**1.75. Tenacious glumes**

**1.76. Tiller inhibition / Tiller number**

**1.77. Uniculm stunt**

**1.78. Yield and yield components**

**1.78.1. Grain number per spike**

**1.78.2. Grain volume weight**

**1.78.3. Grain weight**

**1.78.4 Test weight**

**1.78.5. Grain weight/ear**

**1.78.6. Grain yield**

**1.78.7. Kernel number per square metre**

**1.78.8. Spike number per plant**

**1.78.9. Spikelet number per square metre**

**1.78.10. Spike length**

**1.78.11. Tiller number/plant**

**1.79. Yellow berry tolerance**

1. **Proteins**

**2.1. Grain protein content**

**2.2. Enzymes**

**2.2.1. Acid phosphatase**

**2.2.2. Alcohol dehydrogenase (Aliphatic)**

**2.2.3. Aminopeptidase**

**2.2.4. Alpha-amylase**

**2.2.5. *b*-amylase**

**2.2.6. Endopeptidase**

**2.2.7. Esterase**

**2.2.8. Glucosephosphate isomerase**

**2.2.9. Glutamic oxaloacetic transaminase**

**2.2.10. Hexokinase**

**2.2.11. Lipoxygenase**

**2.2.12. Malate dehydrogenase**

chromosomes **3.2.13. Peroxidase**

**2.2.14. Phosphodiesterase**

**2.2.15. Phosphogluconate dehydrogenase**

**23.2.16. Phosphoglucomutase**

**2.2.17. Shikimate dehydrogenase**

**3.2.18. Superoxide dismutase**

**2.2.19. Triosephosphate isomerase**

**3.2.20. Aromatic alcohol dehydrogenase**

**2.2.21. Aconitase**

**2.2.22. NADH dehydrogenase**

**2.2.23 Dipeptidase**

**2.2.24. Malic enzyme**

**2.2.25. Adenylate kinase**

**2.2.26. Glutamate-pyruvate transaminase**

**2.2.26. Glutamate-pyruvate transaminase**

**2.2.28. Beta-glucosidase**

**2.2.29. Starch branching enzyme I**

**2.2.30. Starch branching enzyme II**

**2.2.31. Benzoxinones**

**2.2.32. Acetohydroxyacid synthase (EC 4.1.3.18)**

**2.2.33. Phytoene synthase (EC 2.5.1.32)**

**2.2.34. Polyphenol oxidase**

**2.2.35. Protein disulfide isomerase (EC 5.3.4.1)**

**2.2.36. Isoamylase 1**

**2.2.37. Polygalacturonase-inhibiting proteins**

**2.2.38. Flavone 3-hydroxylase (EC 1.14.11.9)**

**2.2.39. Zeta-carotene desaturase**

**2.2.40. Carotenoid beta-hydroxylase (non-heme di-iron type)**

**2.2.41 Lycopene-zeta-cyclase**

**2.2.42 Dehydration-responsive element (DREB) proteins; Dehydration response factors (DRF)**

**2.3. Endosperm storage proteins**

**2.3.1. Glutenins**

**2.3.2. Gliadins**

**2.3.3. Other endosperm storage proteins**

**2.3.4. Enzyme Inhibitors**

**2.3.5. Grain softness protein**

**2.3.6. Histone H1 Proteins**

**2.3.7 Iodine binding factor**

**2.3.8 Lipopurothionins**

**2.3.9. Lectins**

**2.3.10. Puroindolines and grain softness protein**

**2.3.11. Endosperm-specific wheat basic region leucine zipper (bZIP) factor storage activator alias Storage protein activator**

**2.3.12. Salt soluble globulins**

**2.3.13. Serine protease inhibitors *alias* serpins**

**2.3.14. Starch granule proteins**

**2.3.15. Starch synthase**

**2.3.16. Water soluble proteins**

**2.3.17. Waxy proteins**

1. **Pathogenic Disease/Pest Reaction**

**3.1. Abiotic stress responses: Dehydrin-response element binding factors**

**3.2. Reaction to Barley Yellow Dwarf Virus**

**3.3. Reaction to** *Bipolaris sorokiniana*

**3.4. Reaction to** *Blumeria graminis* DC.

**3.4.1. Designated genes for resistance**

**3.4.2. Suppressors of *PM* resistance genes**

**3.4.3. Temporarily designated genes for resistance to** *Blumeria graminis*

**3.4.4. QTLs for resistance to** *Blumeria graminis*

**3.5. Reaction to** *Cephalosporium gramineum*

**3.6. Reaction to** *Cephus* spp

**3.7. Reaction to** *Cochliobolus sativus* Ito & Kurib.

**3.8. Reaction to** *Colletotrichum cereale*

**3.9. Reaction to** *Diuraphis noxia* (Mordvilko)

**3.10. Reaction to** *Eurygaster Integriceps*

**3.11. Reaction to** *Fusarium* spp.

**3.11.1. Disease: Fusarium head scab, scab**

**3.11.2. Disease: Crown rot caused by** *Fusarium pseudograminearum, F. culmorum* and other *Fusarium* species

**3.12. Reaction to** *Heterodera avenae* Woll.., *H. filipjeva* (Madzhidov) Stelter

**3.13. Reaction to** *Magnaporthe* spp.

**3.13.1. Reaction to** *Magnaporthe grisea* (Herbert) Barr: Syn. *Pyricularia oryzae*

**3.13.2. Reaction to** *Magnaporthe oryzae*

**3.14. Reaction to** *Mayetiola destructor* (Say) (*Phytophaga destructor*) (Say)

**3.15 Reaction to** *Meloidogyne* spp.

**3.16. Reaction to** *Mycosphaerella graminicola* (Fuckel) Schroeter, *Zymoseptoria tritici*

**3.17. Reaction to** *Phaeosphaeria nodorum* (E. Muller) Hedjaroude

**3.17.1. Genes for resistance**

**3.17.2. Sensitivity to SNB toxins (necrotrophic effectors)**

**3.18. Reaction to** *Pratylenchus* spp

**3.18.1. Reaction to** *Pratylenchus neglectus*

**3.18.2. Reaction to** *Pratylenchus thornei*

**3.19. Reaction to** *Puccinia coronata* var. *hordei*.

**3.20. Reaction to** *Puccinia graminis* Pers.

**3.21. Reaction to** *Puccinia striiformis* Westend.

**3.21.1. Designated genes for resistance to stripe rust**

**3.21.2. Temporarily designated genes for resistance to stripe rust**

**3.21.3. Stripe rust QTL**

**3.21.4. Spike response to stripe rust**

**3.22. Reaction to** *Puccinia triticina*

**3.22.1. Genes for resistance**

**3.22.2 Temporary designations**

**3.22.3. Suppressor of genes for resistance to** *P. triticina*

**3.22.4. QTL for reaction to** *P. triticina*

**3.23. Reaction to** *Pyrenophora tritici-repentis* (anomorph: *Drechlera tritici*-*repentis*)

**3.23.1. Insensitivity to tan spot toxin (necrosis)**

**3.23.2. Insensitivity to tan spot toxin (chlorosis)**

**3.24. Reaction to** *Rhizoctonia* spp.

**3.25. Reaction to** *Sitobion avenae*

**3.26. Reaction to** *Sitodiplosis mosellana* (Gehin)

**3.27. Reaction to** *Schizaphis graminum* Rond. (*Toxoptera graminum* Rond.)

**3.28. Reaction to soil-borne cereal mosaic virus**

**3.29. Reaction to** *Tapesia yallundae*. (Anomorph: *Pseudocerosporella herpotrichoides* (Fron) Deighton)

**3.30. Reaction to** *Tilletia caries* (D.C.)Tul., *T. foetida* (Wallr.) Liro, *T. controversa*

**3.31 Reaction to** *Tilletia indica* Mitra

**3.32. Reaction to** *Ustilago tritici* (Pers.) Rostrup

**3.33. Reaction to wheat spindle streak mosaic bymovirus (WSSMV)**

**3.34. Reaction to wheat streak mosaic virus**

**3.35. Reaction to** *Xanthomonas campestris* pv. *undulosa*

**3.36. Resistance to colonization by** *Eriophyes tulipae* (*Aceria tulipae*)

**3.37. Reaction to wheat yellow mosaic virus**