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Breeding for semidwarf and high grain yield wheats.

Wheat is an excellent food crop for Pakistan. The production of wheat always has been the main occupation of the farmer in the diversified agroclimatic conditions of Pakistan. The evolution of cultivars with high grain yield potential and a desirable combination of traits have always been the major objectives of our wheat breeding programs. During 2009-10, a production of 23.8 x 10^6 tons was achieved from an area of 9.0 x 10^6 hectares. The average yield during the year was 2,639 kg/ha (Table 1).

Table 1. Area, production, and average yield (2009–10) of wheat in Pakistan (Source: Ministry of Food, Agriculture and Livestock, Islamabad Pakistan).

Province	Area (x 10^6 ha)	Production (x 10^6 ha)	Yield (kg/ha)
Punjab	6.894	18.240	2,646
Sindh	1.028	3.650	3,551
Khyber Pakhtunkhwa (NWFP)	0.752	1.184	1,574
Baluchistan	0.368	0.790	2,147
Pakistan	9.042	23.864	2,639

Wheat breeding at NIA, Tando Jam. The objective of the wheat breeding program is to develop high-yielding wheat cultivars endowed with good quality characteristics. These cultivars must possess tolerance to biotic and abiotic stresses. The NIA has released 11 cultivars, including two new cultivars, NIA-Sunhari and NIA-Amber for Sindh province. NIA–Sunhari and NIA–Amber were released on 3 February, 2010.

Salient features of NIA–Sunhari. NIA-Sunhari carries the *Rht1* gene and ranges from 90–100 cm. This cultivar has dark green leaves and possesses a high tillering capacity. NIA–Sunhari was developed for irrigated areas but can produce better yields under drought conditions. The cultivar has excellent quality characteristics, having high protein content (14.92%), a higher percentage of wet gluten (32.86%), dry gluten (11.02%), and an SDS value of 30 CC.

Salient features of 22-03, a candidate cultivar. The candidate wheat cultivar was tested in National Uniform Wheat Yield Trial (NUWYT) during 2008–09. The NUWYT results suggested that 22-03 is completely resistant to leaf and yellow rusts. The relative rateindex for leaf rust was 8.5 and yellow rust 8.7. Line 20-33 also is moderately resistant against a local stem rust race. The line yielded 4,267 kg/ha compared with those of the check cultivars (4,098 kg/ha) under normal sowing conditions. Line 22-30 has a high protein content of 16.42%, a higher percentage of wet gluten (35.19%), a higher percentage of dry gluten (12.4%), and a high SDS value of 35 CC.

Cooperation with the National Institute of Biology and Genetic Engineering (NIBGE), Faisalabad. A new advanced line (C7-98-4) has been sent to NIBGE scientists for wheat transformation (genes for phosphorus use efficiency) during 2008. We are still waiting for the performance of the line.

Collaboration for wheat breeding and genetics during the year 2009–10. Genotypes NIA–Sunhari, 22-03, 54-03, 6-12, and C7-98-4 were sent to the National Agriculture Research Council Islamabad, Pakistan for rust disease screening Genotypes DTSN-06, DTSN-23, DTNS-26, DTNS-29, and DTSN-33 were sent to the Barani Agriculture Research Institute, Chakwal, Pakistan, for drought screening. For plant physiological studies related to drought, the genotypes 54-03, 5-02, NIA–Sunhari, 22-03, and 17-02 were given to the Plant Physiology Division, Nuclear Institute of Agriculture, Tando Jam.

Zonal/regional trial studies. Two candidate lines, 6-12 and CIM-04-10, were grown in eight sites for zonal trial studies during the year 2009–10 in the Sindh province.

Advance Station Trials (Trial I, II, III, and IV). Four trials were grown during the 2008–09 crop year for yield and yield component studies. Trial I, Trial II, and Trial III each consisting of 16 genotypes including the two common check cultivars Sarsabz and Kiran. Trial-IV (isolines) consisted of 34 genotypes including the two checks Sarsabz and Anmol. The trials had three replicates, six rows with a 4-m row length.

Advance Station Trial I. This trial was sown on 21 November, 2008, and consisted of 14 advanced station lines and two check cultivars. In this trial, line 10 produced the highest grain yield (1,850 g/plot). Other lines with high grain yields were 7 (1,817 g/plot), 5 (1,800 g/plot), 9 (1,717 g/plot), 1 (1,692 g/plot), 11 and 13 (1,583 g/plot), and 2 (1,567 g/plot). The possible reasons for the high grain yield in line 10 could be due to an early heading date (70) and better 1,000-kernel weight (42.01 g).

Advance Station Trial II. The trial was sown on 21 November, 2008, and consisted of 14 advanced station lines and two check cultivars. Line 7 had the highest grain yield (1,817 g/plot) followed by line 9 (1,817 g/plot). Subsequent lines with high grain yields were 13 (1,600 g/plot), 5 (1,583 g/plot), 2 and 6 (1,550 g/plot), and 3 (1,542 g/plot). Possible reasons for the high grain yield in line 7 could include that it had the highest main spike grain yield and a better 1,000-kernel weight (40.4 g).

Advance Station Trial III. The trial was sown on 4 December, 2008, and consisted of 14 advanced station lines and two check cultivars. In this comparison, line 11 had the highest grain yield (1,500 g/plot), followed by lines 4 (1,433 g), 2 (1,350 g/plot), 5 and 12 (1,325 g/plot), and 9 (1,233 g/plot). The high grain yield in line 11 could due to its high number of spikelets/spike (20.6).

Advance Station Trial IV (isoline studies). This trial was sown on 13 November, 2008, and consisted of 32 advanced station lines and two check cultivars. In this comparison, line 30 had the highest grain yield (2,083 g/plot). Other lines with high grain yields were 29 (2,033g/plot), 7 (1,967 g/plot), 22 (2,025 g/plot), and 7 (1,967 g/plot).

Mutation breeding studies.

Radiation studies in the M_3 generation. Selected M_3 plants were grown in progeny rows under normal soil conditions from irradiated material of cultivars Bhittai and Kiran-95. A total of 97 M_3 progenies of mutated breeding material were sown in two replicates with 1-m rows. Data were recorded for morphological characters and days-to-heading under field conditions. The data for yield and its components are being recorded. Mutant M_3 plants were selected for M_4 generation.

Selected M_3 bulk material also was grown under saline soil conditions; the salinity ranging from 17 to 41 ECe ds/m. The trial consisted of irradiated breeding material of the cultivars Bhittai and Kiran-95 planted in six 2-m rows in three replicates. Data were recorded for morphological characters and days-to-heading under field conditions. The data for yield and yield components are in progress to be recorded. Mutant M_3 progenies were selected for M_4 studies.

Drought tolerance studies.

Thirty-six genotypes of wheat were selected for drought studies during 2009–10. The trial consisted of three replicates; each entry had two 1.5-m rows. Four treatments were used; treatment 1 had zero/no irrigation, treatment 2 had two irrigations, treatment 3 had three irrigations, and treatment 4 received four irrigations. The data were recorded for days-to-heading and plot grain yield (g). Genotype C6-98-7 had an earlier heading date (63 days) under zero/no irrigation than the check cultivar Margalla (65 days). Genotypes that had a comparatively higher grain yield than the best check cultivar Margalla (202 g) were 29-02 and C7-98-4 (222 g), C3-98-8 (213 g), CIM-03-2 and C6-98-5 (208 g), CIM-04-1 (212 g), and C2-98-7 (242 g) under zero/no irrigation. The genotype C2-98-7 (317 g) with two irrigation had a higher grain yield than best check cultivar Margalla (314 g). Other genotypes that had higher grain yields than that of Margalla (320 g) under three irrigations were 4-03 (322 g), CIM-04-1 (345 g), C2-98-7 (330 g), and C6-98-5 (347 g). With four irrigations, genotypes with a higher grain yield than Margalla (386 g) were CIM-04-1 (427 g) and C2-98-7 (413 g). The mean performance over the four treatments showed that the check Margalla was early heading; 70 days. The grain yield for check cultivars were Margalla (306 g), Khirman (182 g), and Chakwal (182 g). Genotypes with higher grain yiel/plot were CIM-04-1 (311 g), C2-98-8 (326 g) ,and C6-98-5 (308 g).

Publications.

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NATIONAL AGRICULTURAL RESEARCH CENTER (NARC), ISLAMABAD WHEAT WIDE CROSSES AND CYTOGENETICS AND COLLABORATING NATIONAL PROGRAMS
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Wheat wide crosses and general wheat improvement trends: initiatives and the course ahead.

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Wheat production in 2010 reached near 24 x 10^6 tons at approximately 2.6 t/ha. The yield projection for the approaching harvest in 2011 has been projected between 24.5 to 25 x 10^6 tons, and this is primarily due to congenial environmental conditions across the country. No change in the production constraints that prevail to achieve projection targets was observed. Abiotic stresses of drought and salinity/sodicity remain with heat merging as a major concern due to the cropping systems that are in place. The rusts still rank as number one biotic stress priority, with yellow and leaf rust the biggest. Stem rust, around the local race prevalent in lower Punjab and in the province of Sindh, is carefully monitored because, if confounded by Ug99 when it reaches Pakistan, will pose a serious hazard. National scientists have released varieties that are Ug99 resistant based upon screening in Kenya and advanced breeding materials in conventional national breeding programs also are added sources of new resources. Extensive new genetic diversity is crucial for achieving security against this biotic stress and an on-base research program is a dire need.

A strong prebreeding program firmly in place in Pakistan is paramount and has been initially planned by mid-2010. Unfortunately, both CIMMYT and ICARDA leadership have set in place an operational plan where the CIMMYT Pakistan representative has stated that all prebreeding under the Pak-U.S. bilateral alliance will be done in U.S. This is a set-back to our national efforts, where the forward direction should be to evolve and upgrade the developing country programs promoting scientific advancement integrated with U.S. elite scientific institutions, which was the spirit earlier advocated by the Pak/U.S. partners in 2009 and 2010. Our current program is actively involved in prebreeding and has made impact. International center decisions have not helped our national cause in moving ahead swiftly around volatile young, human, resource strength that is being generated progressively. Despite this temporary constraint, our wide crossing program is moving ahead and has rapidly restructured around new partners hoping that the earlier linkages will fall back in place.

Our new Wheat Wide Crosses Program has identified Ug99 resistant lines through crosses involving D-genome synthetic hexaploid germ plasm. Furthermore, the derivatives also are resistant against the local race of stem rust identified upon screening in Sindh. The nature of the local race has to be elucidated and the Cereal Disease Program of NARC is on the front line for this informational sharing. Resistant, derived lines from Wheat Wide Crosses to Ug99 are shown in Table 1 (p. 82).