D.W.R. Flowerdale, Shimla, H.P.

REGIONAL STATION, D.W.R. FLOWERDALE, SHIMLA-171002 H.P.

This station came into existence during 1930 with the efforts of Late Rai Bahadur Dr. Karam Chand Mehta , F.N.I., Ph.D (Cantab.), D.Sc., Prof. Botany, Agra College, Agra. Dr. Mehta's interest in rusts got aroused while working with Prof. F.T. Brookes, Fellow Royal Society in the 3rd decade of twentieth century in U.K. He hired the building that now hosts office and laboratories by spending his personal savings and the station remained under his control up to 1950. After his demise in 1950, the station was taken over by Govt. of India as a part of IARI under Ministry of Food and Agriculture. Since 1991 it is one of the constituent regional stations of Directorate of Wheat Research.

Flowerdale center is spread over 3.5 acres, situated 2000 M amsl with cool, dry climate and annual precipitation about 200 cm. well spread over the year. The station was short listed by Dr. Mehta out of Murrey (Pakistan), Almora and Agra because of its suitability for growing wheat and maintaining rusts all over the year with ease.

Yellow Rust

Brown Rust

Black Rust

The station is engaged in research on rusts of wheat and barley since 1930. At present black (stem) rust of wheat and barley (*Puccinia graminis* Pers. f. sp. *tritici* Eriks. & Henn.), Brown (leaf) rust of wheat (*P. triticina* Eriks.) and yellow (stripe) rust of wheat (*P. striiformis* West. f. Sp. *tritici*) yellow rust of barley (*P. striiformis* West. f. sp.*hordei*) , and brown (leaf) rust of barley (*P. hordei* Otth.) are the focus of research. In addition cultures of crown rust of oat (*P. coronata* Cda.. f. sp. *avenae* Fraser and Ledingham) , black (stem) rust of oat (*P. graminis* f. sp. *avenae* Eriks. and Henn.) and Linseed rust (*Melampsora lini* (Ehrenb.) Lev.) are also being maintained.

Sphere of Work:
Line of work at the station is given briefly as:
1. Monitoring variability in wheat and barley rusts and identify new pathotypes, if any.
2. Evaluation of advance varietal trial/breeder's material of wheat and barley against rusts and find out the rust resistance sources.
3. Characterize rust resistance genes/diversity for rust resistance in Indian wheat material.
4. Maintenance, preservation and supply of nucleus inocula of more than 100 pathotypes identified since 1930.
5. Develop rust resistant genetic stocks, study genetics of rust resistance, adult plant resistance, slow rusting and polymorphism in wheat rusts at DNA level.
6. Design strategies for wheat rust management through host resistance.

Facilities:
The station has 12 glasshouses with four having air conditioned facility, a small molecular lab, deep fridges (-20°C, -80°C), liquid nitrogen facility for storage of inocula, field area about 2 acres for multiplication of seed and advancing of generations. The station has full fledged facility to look after pathotyping in wheat and barley rusts, evaluation of germplasm, characterization of rust resistance genes, inheritance studies, molecular work and is custodian of all the pathotypes of wheat and barley rusts identified since 1930 and is credited with the supply of nucleus inoucla in the country.


Glass house facility at Flowerdale

Achievements:

1. Variability in wheat and barley rusts

Monitored variability in wheat and barley rusts since 1930. More than 100 pathotypes have been identified in initial stages in different rust pathogens. Resistance sources have been identified against these pathotypes. Every year more than 1500 samples of wheat and barley rusts are analyzed. Pathotype 121R63-1, 21R55 and 21R63 of *P. triticina* (brown rust), 62G29 and 58G13 of *P. graminis tritici* (black rust) and 46S102 (Nilgiri hills, 46S1119 and 78S84(northern India) of yellow rust of wheat are prevalent in India. In barley yellow rust pt. 1S0 was frequent. Recently six new pathotypes (pts.) of *Puccinia triticina* were identified. Virulence for *Lr19* (253R31) has rendered resistance genes *Lr19* susceptible. Another pt. 29R45 is virulent on many *Lr*genes, bread, durum, dicoccum wheat and even some of the barley lines. Pathotypes 5R45 and 93R39 virulent on *Lr26* were also recorded for the first time. Two other new pathotypes 29R7, 5R9-7, later one virulent on durum and dicoccum, were also identified. Two new pathotype of *P. graminis tritici*, 55G1 with additional virulence on*Sr9b* and 58G13 with virulence to *Sr9b, Sr9e, Sr30* and *Sr36 were* also detected for the first time. Resistance sources against all these pathotypes were also identified.

Prevalent pathotypes of wheat rusts

RUST OF WHEAT	PREDOMINANT PATHOTYPES	
	SOUTH INDIA	REST OF INDIA
BROWN	122R63-1	121R63-1, 21R55, 21R63
BLACK	62G29, 58G15	62G29
YELLOW	38S102	46S119, 78S84 (2006)>

2. Registered 22 rust resistant genetic stocks

Registered more than 22 rust resistant genetic stocks with N.B.P.G.R., New Delhi. Recently registered 17 rust resistant genetic stocks are FLW6 (INGR 04011), FLW8 (INGR 04012), FLW11

(INGR 05003), FLW12 (INGR 05004), FLW13 (INGR 05005), FLW15 (INGR 05006), RNB1001 (INGR 05007),
HW2002 (INGR 04014), HW2031 (INGR 04015), HW2049 (INGR 04016), FKW1 (INGR 06004), FKW3 (INGR06005), FLW20 (INGR07001), FLW24 (INGR07005), FLW25 (INGR07006), FLW26 (INGR07007) and FLW27 (INGR07008). These carry diverse resistance genes against wheat rusts in agronomically acceptable background.

3. Rust Resistance

More than 700 advance lines/ breeder's material are evaluated for rust resistance every year using more than 80 pathotypes of wheat and barley rusts. HW5021 and HW5044 were found resistant to all the rusts. More than 500 lines holding rust resistance have been identified during the years.

4. Rust resistance genes

To know the diversity for rust resistance *Lr, Sr* and *Yr* genes are characterized through gene matching technique. During last three years rust resistance genes were characterized in more than 550 lines. While 10 *Lr* genes viz. *Lr* 1, *Lr* 3, *Lr9*, *Lr*10, *Lr*13,*Lr*14a, *Lr*23, *Lr*24, *Lr*26 and *Lr*34 were characterized in 350 lines whereas 11 *Sr* gene viz. *Sr 2, Sr 5,*
Sr 7b, *Sr* 8a, *Sr* 8b, *Sr* 9b, *Sr* 9e, *Sr* 11, *Sr 12, Sr* 24 and *Sr* 31 were postulated in 378 lines.
Five *Yr* patterns viz. *Yr* 2*, Yr*2(KS), *Yr*3, *Yr*9 and *Yr* 18 were postulated in about 180 lines.

Rust resistance gene	
Lr	*Lr1, Lr3, Lr9, Lr10,* ***Lr13****, Lr14a,* ***Lr23****, Lr24,* ***Lr26, Lr34***
Sr	***Sr2, Sr5****, Sr7b, Sr8a, Sr8b, Sr9e,* ***Sr11****, Sr12, Sr24,****Sr31***
Yr	*Yr2, Yr2(KS), Yr3,* ***Yr9, Yr18***

5. Repository of pathotypes

Maintained more than 100 pts. of *P. graminis tritici*, *P.triticina , P.striiformis*, *P. graminis avenae*, *P.coronata*, *P. hordei* and *Melampsora lini* both as live cultures and in ultra low temperature conditions. For facilitating genetic as well as epidemiological work their nucleus inocula were supplied to different wheat 50 scientists/centers every year in the country for creating epiphytotics and conducting genetic studies.

6. Adult plant resistance to rusts

Recently more than 150 lines with adult plant resistance to one or more pathotypes of rusts were identified. Race specific adult plant resistance to both brown and yellow rusts was observed in HD2937, HPW251, HS461, HUW598, PBW574, PBW575, PBW579, PBW 561, PDW300, TL2949, VL882, VL892, and WH1021. GW322 and NIAW34 showed APR to most virulent and predominant pathotypes of brown rust. Remaining lines possessed APR to one or other pathotype of P. *triticina* or *P. striiformis*.

7. Co-ordination of wheat disease trap plot/ SAARC nursery

To monitor occurrence and spread of wheat diseases, wheat disease trap plot /SAARC nurseries were organized which were planted in 37 and 15 locations, respectively and 12 locations in Bangladesh, Bhutan, Nepal and Pakistan every year.


APR to Brown Rust

8. Deciphered the genetic basis of rust resistance of important wheat accessions

Inheritance of rust resistance revealed four brown rust res. genes, two black rust res. genes and four yellow rust res. genes to confer resistance to rusts in PBW343 whereas one dominant gene each in Centurk, Arkan and BlueBoy against brown rust. Studies on inheritance of adult plant resistance studies suggested the presence of two complementary recessive genes in DWR 195, two completely dominant genes in RAJ3765 and two independent dominant genes in HP1731 against brown rust. Additionally, two recessive genes were identified in Agra Local which was known to

be susceptible to all the known pathotypes of brown rust. At least three new *Lr* genes have been observed in durums.

9. Resistance sources against UG99

The emergence of Ug99, a pathotype of *Puccinia graminis tritici* in Uganda has threatened cultivation of wheat germplasm covering 40% of world acreage. Rust resistant genetic stocks developed at Flowerdale i.e. FLW2, FLW6, FLW8,14 and others could confer resistance to this pathotype and are available for breeders' use.

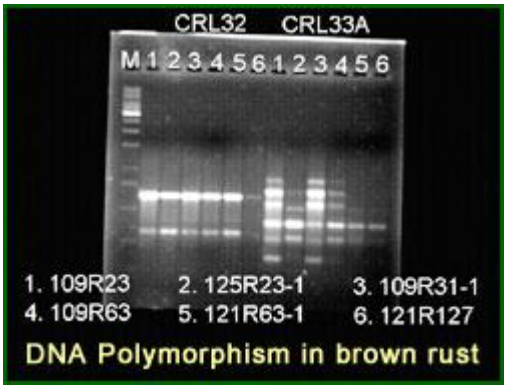
10. Externally funded projects

In addition to the core project, we were associated with five externally funded projects worth 2 crores of rupees. NATP, Team of Excellence on Virulence Typing and Genetics of Rust Resistance in Wheat for Rs. 1.22 crore concluded in 2005, whereas DBT project on Development of varieties with durable resistance to leaf and stripe rusts using molecular marker technology in bread wheat concluded recently.

No rust epidemics during last 35 years

11. Collaborative research

Collaborated with NCL, Pune in work on marker for *Sr30* and confirmation of desired resistance with IARI, New Delhi/ Wellington, HAU Hisar, PAU, Ludhiana, ARI, Pune, BARC, Bombay and other institutions.



12. Molecular studies

More than 300 high GC-rich primers were screened. A few of them were informative. Finally, ten primers namely, CRL 20, CRL 21, CRL 22, CRL 29, CRL30 and CRL 31 CRL 32, CRL 33a, CRL33b and CRL34, were used to resolve the DNA polymorphism in brown rust pathotypes of race group, 12, 77 and 104. Marker assisted selection technique helped validate the presence of *Lr9, Lr19, Lr24, Lr26, Lr28* and *Yr 15* in host population. New marker was designed and developed for *Yr10,* which confers resistance to yellow rust of wheat in India.

13. No epidemic of wheat rusts during the last 35 years

A mild loss of 5 percent by wheat rusts can cause yield reduction of 3.5 million tonnes in India. It equals approximately to loss of Rs. 3500 cores. The timely detection of new variants and the identification of resistant material, thereafter, have prevented any major loss to wheat. The strong and vibrant programme of monitoring wheat rust virulences has paid rich dividends to the nutritional and food security of the country, which did not witness any major rust out break in the last 35 years. Our efforts of managing wheat rusts involves only the use of available resistance and its intelligent deployment based on pathotype distribution. Through pre-breeding activities the genetic base of rust resistance in wheat was diversified. The new and unutilized rust resistance genes namely, *Lr19, Lr32, Lr39, Lr42, Lr45, Yr5, Yr10, Yr15*, *Yr*(CD),*Yr*(Mega), *Yr*(Hobbit), *Yr*(SP), *Yr*(China-84), introgressed in elite varieties, will flow into the future varieties. This will reduce the danger of rust epidemics. Therefore, the use of chemical is avoided and we rely on ecologically safe and green approach for tackling wheat and barley rusts.