

PREFACE

Chronologically, the history of dwarf wheat cultivation in India is as follows:

3000 B.C. (Mohenjo-Daro period): The Indian dwarf wheat, Triticum sphaerococcum, was widely cultivated in the North-Western parts of India. Due to its low yield potential and high susceptibility to rusts, its cultivation gradually dwindled and the species is now only maintained in research institutions.

1962: I.A.R.I. concluded that varieties with the "Norin" genes for dwarfing are essential for breaking the barriers to high yields in irrigated wheat. A request was made to the Rockefeller Foundation for the seeds of such dwarf wheats already developed in Mexico and for arranging the visit of Dr. N.E. Borlaug to India.

1963: Dr. N.E. Borlaug visited the wheat growing regions of India and despatched 100 Kgs each of 4 dwarf and semi-dwarf wheat varieties and small samples of 613 promising selections. The material was grown and studied at Delhi, Ludhiana, Pusa, Kanpur, Pant Nagar, Bhowali and Wellington.

1964: The Mexican varieties Lerma Rojo and Sonora 64 yielded over 4 tonnes per hectare at Delhi, Ludhiana, Pusa and Kanpur. Seeds were multiplied during summer in the Nilgiri Hills in South India. During the rabi season, the dwarf wheats were tested at 155 locations under the All-India Co-ordinated Wheat trials. The dwarf varieties were subjected to detailed pathological, physiological, agronomic and quality evaluation.

1965: The results from yield trials conducted all over the country led to the release of Lerma Rojo and Sonora 64 for general cultivation. The new agronomic practices necessary for enabling the dwarf strains to reveal their yield potential were standardised. Seeds of the dwarf wheats were multiplied in the Nilgiris during summer months.

WHEAT DISEASES AND THEIR CONTROL

Diseases of wheat:- Wheat suffers from several diseases which cause both a substantial reduction in yield and a deterioration in the quality of the grain. Some of the well known diseases of wheat in India are black rust (Puccinia graminis tritici), brown rust (Puccinia recondita), yellow rust (Puccinia striiformis), loose smut (Ustilago nuda var. tritici) flag smut (Urocystis tritici), karnal bunt (Neovossia indica) hill bunts (Tilletia foetida and T. caries), powdery mildew (Erysiphe graminis), leaf blotch and glume blotch (Septoria nodorum and S. tritici), foot rot (Helminthosporium spp.) ear cockle and "tundu" (Corynebacterium tritici and Anguina tritici), black point (Alternaria, Helminthosporium spp.) and mosaic streak (virus).

Losses due to diseases:- Amongst these diseases, rusts, smuts, bunts and leaf blights are quite destructive and take a heavy toll annually. Black and brown rusts are prevalent throughout the country wherever wheat is cultivated but yellow rust is mostly restricted to North-West regions of the country and in the Nilgiri and Pulney Hills of South India. Rust epidemics have been recorded in India from time to time. In 1839 a severe epidemic of rust was recorded from Narbada Valley. In recent years, rust appeared in an epidemic form in 1946-47 in Madhya Pradesh, Maharashtra and Southern parts of Uttar Pradesh. The loss was so acute that many cases cultivators did not even recover as much grain as had been

used as seed. Ten years later, rusts appeared again in an epidemic form in the eastern part of the country and created famine conditions in Bihar. Even ~~though~~ though exact figures for overall losses caused by rusts are not available, it has been scientifically shown that the average loss may be between 15-20% in normal years, ⁶ But in epidemic years, it is many times more.

Loose smut (Ustilago nuda) is equally widespread and is present throughout the country. As a result of extensive surveys carried out in the States of Delhi, Punjab, Haryana and Himachal Pradesh during the rabi season of 1967-68, a loss of 7-8% was recorded due to this disease. Hill bunts (Tilletia foetida and T.^c caries) not only cause reduction in yield but also impart a fishy odour and thereby impair the quality of the flour. Black point disease, caused mainly by Alternaria tenuis and Helminthosporium sp. has been reported in last 'rabi' season from many parts of Haryana, Punjab, Himachal Pradesh, Uttar Pradesh and Delhi and in certain cases appreciably reduced the market value of the grain.

Introduction of dwarf wheats and their likely impact
on the disease situation

Since 1963, a new situation has been created by the introduction of dwarf varieties and the changes in the pattern of wheat cultivation. These wheats have tremendous potential for increasing wheat production and have become quite popular particularly in irrigated

areas. During 1967-68, the chief varieties in farmers' fields were Lerma Rojo, S.227, Sonora-64, P.V.18 and Kalyan-Sona. All these varieties need high fertility levels and 4 to 6 irrigation for the full exploitation of their yield potential and when the crop is grown under such conditions, disease problems become more severe. Some of the minor or unimportant diseases may gradually become more important in near future due to changes in the races of pathogens ^{and} varieties showing a high degree of disease resistance now may not continue to be resistant. The reactions of some varieties to the important diseases, as observed in field and glasshouse tests are given in Tables and their performance during last three years is summarised below:-

Lerma Rojo:- In general, it exhibited a high degree of resistance to rusts and during the last two crop seasons it has been practically free from rust attack. It is moderately resistant to Alternaria and Helminthosporium. Though under conditions of artificial epidemics, it was found susceptible to loose smut, the incidence of disease during 1967-68 was negligible in farmers fields.

Safed Lerma and Sonalika: In field performance these varieties are like Lerma Rojo. Under glasshouse tests, however, they exhibited resistance to more races of rusts than Lerma Rojo. During the 1967-68 crop season, Sonalika was seldom reported to have smut infection.

S.227:- The bulk population possesses a high degree of resistance to black rust but is susceptible to brown rust. It is resistant to hill bunt but susceptible to karnal bunt and moderately resistant to yellow rust. Field observations have revealed no smut incidence anywhere in the country during the last 3 years, and preliminary screening in the laboratory has indicated that the variety might possess a high degree of resistance to loose smut.

Kalyan-Sona: This is a selection for brown rust resistance in S.227. In 1967-68, it gave a good performance in farmers' fields. There are occasional reports of black and brown rusts but on the whole the variety stood well against rusts.

S.331(Choti Lerma): Among the new selections, this is the most promising one for rust resistance and during the last two seasons, it was practically free from rusts. Even under glasshouse conditions, it was the most resistant variety to black rust. It has been reported to be resistant to Molya Disease as well.

Sonora-64: This variety is susceptible to yellow rust and in the last crop season was infected by yellow rust particularly in the Punjab and West U.P. It possesses a fair degree of tolerance to brown and black rusts. There were, however, reports of black rust incidence from Coimbatore in 1967-68. It is moderately resistant to

Alternaria and Helminthosporium but is very susceptible to loose smut.

Sharbati Sonora has nearly similar disease reactions as Sonora-64, except that it shows under field conditions greater freedom from yellow rust.

Extensive surveys carried out in 1967-68 have shown that by and large the dwarf varieties gave a much better performance than the indigenous varieties in respect of disease resistance. In the month of March the intensity of brown rust increased considerably and in many parts of the country particularly in Bihar, U.P., Punjab and Haryana the local varieties were heavily rusted but most of the dwarf varieties were comparatively free from disease. Sonora-64, however, showed loose smut infection in many fields but S.227 and Kalyan-Sona did not have any infection of the disease. But for the widespread cultivation of the rust-resistant dwarf wheats during 1967-68 rusts would have caused a severe damage to the wheat crop, particularly in irrigated and fertilized fields.

The black-point disease, caused mainly by Alternaria and Helminthosporium spp. was prevalent in many parts of Uttar Pradesh, Punjab, Haryana and Delhi States. Preliminary investigations have shown that it was prevalent mainly in those parts of the country where there was a high atmospheric humidity or rainfall ~~wh~~ after the seed-setting. The incidence of the disease varies considerably from region to region but certain varieties like K.68, C.273, NP 880, PV.18 and Lerma Rojo

appear to be more prone to this disease than the other varieties.

Control Measures: For the best exploitation of the yield potential of the dwarf wheats, it is imperative that the disease incidence is kept under check. From the foregoing account it would be evident that the varieties though resistant to quite a few pathogens, are also susceptible to some diseases and under favourable conditions the latter diseases can assume a severe epidemic form. In recent years, Karnal bunt (Neovossia indica) has been reported from many places in the western regions of the country and occurrence of Helminthosporium spiciferum and a mosaic disease has been recorded on the Mexican wheats. These diseases though extremely limited at present could become destructive due to introduction of new agricultural practices and changes in ecological environments.

The use of resistant varieties offers the best method for the control of many diseases. Breeding for resistant varieties, as is well known, is a continuous process requiring new varieties from time to time to replace the existing ones, as new strains of pathogen make their appearance. Another method of control is the use of chemicals. However, the use of chemicals has been limited in India due to economical and technical reasons. Certain dithiocarbamates have shown good promise in the control of leaf rust and leaf blight caused by Alternaria

tritricina. Parzate liquid + zinc sulphate has given effective control of black and brown rusts. Loose smut and flag smut of wheat can be very effectively checked by Vitavax, a recently developed systemic fungicide from U.S.A. by treating the infected seeds before sowing. Loose smut can also be controlled by solar heat treatment. Incidentally, while soaking the seed in water for solar-heat treatment the nematode galls can also be separated to check the main source of infection of the "Tundu" ^{and} Ear-Cockle diseases. Some of the externally seed-borne diseases, like Hill bunts, can be kept under reasonable control by treating the seed with mercurial compounds such as Agrosan GN. Seed treatment by mercurial compounds is also effective against seedling blight caused by Helminthosporium sp. Besides protecting the seed against the seed-borne pathogens, mercurial seed-treatment has also a stimulatory effect on the germination of seedlings.

TABLE 13-SEEDLING REACTION TO BLACK RUST

Sl. No.	Varieties	Races	11	14	15	15C	17	21	21A	21-A-1	24	34	34A	40	40A	42	42B	42-B -3	117	117A	122	Loose* smut	Karnal Bunt	Hill Bunt	Alterna- ria.	
1.	S.227		R	R	R	R	R	RR	R	R	R	S	R	R	R	S	S		R	R	S	R	S	R	-	
2.	S.307(Safed Lerma)		R	S	SR	R	R	R	R	R	R	S	R	-	R	R	SR	SR	S	R	S	S	S	S	SR	
3.	S.308 (Sona- lika)		S	R	R	R	SR	R	R	SR	R	R	S	R	-	S	SR	SR	R	-	S	-	S	S	SR	
4.	Kalyan Sona 227		SR	R	R	-	R	R	-	R	-	-	SR	R	-	R	R	-	SR	-	R	-	-	S	-	
5.	S.331(Choti Lerma)		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	S	S	S	
6.	LermaRojo		R	SR	R	R	R	R	R	R	R	S	S	SR	R	S	R	SR	S	R	S	S	S	-	SR	
7.	Sonora 63		S	R	R	SR	R	R	R	S	R	R	S	R	-	S	R	-	R	R	SR	S	S	SR	SR	
8.	Sonora 64		S	R	R	SR	R	R	R	R	R	R	SR	R	-	R	R	-	R	R	S	S	S	S	SR	
9.	Sharbati Sonora		S	R	R	R	-	-	R	R	-	-	SR	R	-	R	-	-	-	R	-	S	-	-	S	SR
10.	Penjamo		S	R	-	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	-	R	R	-
11.	Nadadores		R	R	R	R	R	R	R	R	R	S	R	R	-	SR	R		R	R	R	R	R	S	-	
12.	P.V.18		S	R	R	S	R	R	R	R	R	S	R	-	S	R	R		R	R	S	R	S	SR	-	

R = Resistant

S = Susceptible

SR = Moderately resistant

* = Based on two years results.

TABLE 14-SEEDLING REACTION TO BROWN RUST

Sr. No.	Races ¹ Varieties	10	11	17	20	26	65	70	77	106	117	107	108	131	162	162A	D
1.	S.227	R	R	S	SR	-	SR	-	S	SR	S	S	R	S	S	-	-
2.	Kalyan Sona 227	R	R	S	R	-	R	-	S	SR	R	R	SR	-	-	-	-
3.	S.307(Safed lerma)	R	R	R	S	S	R	R	R	R	R	R	R	SR	SR	R	-
4.	S.308 (Sonalika)	R	R	S	R	-	R	-	-	R	R	R	R	-	-	-	-
5.	S.331(Choti lerma)	S	R	SR	S	-	R	-	S	R	S	SR	S	SR	S	-	-
6.	² Lerma Rajo	SR	R	S	S	SR	SR	-	S	R	R	SR	R	SR	SR	SR	SR
7.	Sonora 63	SR	R	R SR	R	R	R	R	R	R	R	R	R	R	R	R	R
8.	Sonora 64.	R	R	S	SR	R	R	R	S	R	R	SR	R	R	R	R	R
9.	Sharbati Sonora	R	R	S	R	-	R	-	-	R	R	SR	-	-	-	-	-
10.	Penjamo	R	R	R	R	-	R	-	R	R	R	R	R	R	R	R	R
11.	Nadadpres	R	R	R to SR	R	SR	R	R	-	R	SR	SR	R	S	S	R	R

R = Resistant

S = Susceptible

SR = Moderately resistant

TABLE 15-SEEDING REACTION TO YELLOW RUST

31 No.	Races	13	19	20	24	31	A	Mixture of races
	Varities							
1.	Sonora 63	S	SR	S	R	S	R	-
2.	Sonora 64	S	SR	S	R	S	R	-
3.	Lerma Rajo	R	S	S R	R	SR	R	-
4	P.V.18	S	S	S	R	S	S	-
5.	Nadadores							SR
6.	Kalyansona							SR
7.	Choti Lerma S.331							SR
8.	Sharbati Sonora							SR

R= Resistant

S= Susceptible

SR= Moderately resistant