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DWARFS WITH GIANT POTENTIAL

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It is now clear that fertilizer response is more a morphological than physiological problem and that unless the plant has a morphological frame which enables it to resist lodging, the application of fertilizers and water in quantities required for high yields is not possible. If the variety is not tailored to the needs of high fertility conditions, the yield may even tend to get depressed with the application of nitrogen doses exceeding about 50 kgs. N per hectare. A short, non-lodging habit is hence a pre-requisite for introducing a new agronomy capable of enhancing yields.

The first variety which appeared to have the desired combination of short plant height, lodging resistance and kernel type was the Japanese variety Norin 10. This variety was one of a collection of Japanese wheats brought to the United States by Dr. S.C. Salton in 1948.

Using the ...

Using the Norin dwarfing genes, the dwarf winter wheat variety, Gaines, was developed by Dr. Vogel in the Washington State, United States. Spring wheat varieties had been developed in Mexico by Dr. N.E. Borlaug, using the Norin genes for dwarfing.

In order to develop dwarf wheat varieties suitable for cultivation in India, the Indian Agricultural Research Institute, New Delhi, introduced in 1963 a large variety of wheat material containing the Norin dwarfing genes from Mexico through the courtesy of the Rockefeller Foundation and the Mexican Ministry of Agriculture. In addition to breeding material, bulk quantities of four commercial Spring Wheat varieties -- Lerma Rojo 64A, Sonora 63, Sonora 64 and Mayo 64 were also obtained. These varieties were tested in all the wheat growing States of India during the rabi seasons of 1963-64 and 1964-65 under the All-India Wheat Improvement Project. In addition, they have been subjected to detailed physiological, pathological, chemical and agronomic tests at the Indian Agricultural Research Institute. Two of these varieties, Lerma Rojo 64A and Sonora 64 were approved by the Central Variety Release Committee of the Indian Council of Agricultural Research in 1965 for cultivation in irrigated areas.

Lerma Rojo is a late variety with a high degree of resistance to yellow rust. It performs very well under timely sown conditions and in areas characterised by yellow rust epidemics.

Sonora 64, on the other hand, is an early variety, well suited for being grown in rotations like maize-wheat, potato-wheat, rice-wheat, etc. It is the most lodging resistant variety . . .

variety so far developed. Being early, it is safe for cultivation under high fertility conditions in the eastern part of U.P., Bihar, West Bengal, Rajasthan, Madhya Pradesh, Gujarat, Maharashtra and Orissa. Sonora 64 should not be sown before the middle of November in areas where the normal sowing time is late October or early November. It is susceptible to yellow rust and hence is not recommended for areas where yellow rust appears in an epidemic condition.

#### CHARACTERISTICS

Disease Resistance: Resistance to individual races of rusts was studied at the Division of Mycology and Plant Pathology of I.A.R.I. It has been found that Sonora 64 possesses resistance to 12 races each of black and brown rusts and four races of yellow rust. It is susceptible to loose smut and hence in seed farms the seeds should be treated against smut infection. Lerma Rojo is resistant to eight races of black rust, six races of brown rust and seven races of yellow rust.

Lodging Resistance: Sonora 64 has two genes for dwarfing, while Lerma Rojo has one such gene. As a consequence, Sonora 64 has a very high degree of resistance to lodging.

Growth Pattern: Detailed studies of growth and development in the dwarf wheats have shown that Sonora 64 produces only six to eight tillers all of which come to maturity synchronously. Using a seed rate of 100 kilograms per hectare and four to five irrigations, yields of five to six tonnes per hectare have been obtained. The synchronous tillering habit enables this variety to make an effective use of <sup>the</sup> fertilizer and water applied.

Biochemical . . .

Biochemical Characteristics: The protein and other quality characteristics have been studied in detail. The average protein content of the grain was found during 1964-65 to be 14.6 per cent. While Lerna Rojo is a soft wheat, Sonora 64 has strong gluten and has good chapatee-making qualities. When N is in abundant supply, irrigation during grain development does not lead to mottling of grain. The grains have a red colour.

Agronomic and Cultural Requirements: The dwarf wheats showed a very poor stand at several trials. The seeds showed 100 per cent germination in petri dishes but the emergence of seedlings in the fields was poor. This was found to be due to the deep sowing of the seeds which tall varieties tolerate but dwarfs do not. The dwarf strains have a short coleoptile, which is unable to penetrate a long distance if placed deep. Sonora 64 is particularly affected by the type of sowing practised by our farmers, who often sow wheat at a depth of four to six inches so as to place the seeds in the region of the soil which has adequate moisture. If a pre-sowing irrigation is given, there will be enough moisture in the upper strata of the soil and the seeds can be sown at a depth of two inches from the surface. Germination and tillering of Sonora 64 and Lerna Rojo are then excellent. Irrigations prior to sowing and during grain development (February and March) are exceedingly important for realising the full yield potential of these varieties. In Delhi, the maximum temperature during March ranges from 29 to 32°C and, usually, hot dry winds occur. While the normal varieties will lodge if an irrigation is given under such conditions, the dwarfs can be safely irrigated.

Yielding . . .

Yielding Ability: Yield tests conducted during 1964-65 have confirmed the expectations these varieties raised during 1963-64. Lerma Rojo, because of its higher degree of yellow rust resistance, has been found to do well in parts of Punjab and U.P., where yellow rust is a problem. Sonora 64 does very well in all areas where yellow rust is not a problem. A yield of 6.4 tonnes per hectare was obtained with this variety at Delhi and Dohad (Gujarat) during 1964-65.

New Selections: Varietal diversity as well as rapid replacement of varieties are essential for sustaining high wheat yields over many seasons. From the advanced generation material sent by Dr. N.E. Borlaug in 1963, several selections such as S.227 and S.307 have been found to perform very well in the Northern Plains zone. Both these strains have amber grains and a high yield potential. The highest yield in national demonstrations in 1965-66 was obtained with S.227, which yielded 68 quintals per hectare in a farmer's field in the Punjabkhod Village of Delhi State. S.307 is a derivative of a cross involving Lerma Rojo and the Japanese dwarf strain Norin 10-B. S.307 has superior rust resistance. The original stock of S.227 received from Mexico segregated for resistance to brown rust and selections have been made for resistance. Seeds of S.227 and S.307 were multiplied at Wellington in the Nilgiri Hills during the summer of 1966 and these varieties are undergoing extensive yield tests.

Besides the selections made at the Indian Agricultural Research Institute, valuable selections were made at Ludhiana, Pant Nagar and Durgapura in the dwarf material sent to them. At Ludhiana, two selections PV.18 and S.227 have been found to do well. . . .

well. Selections for brown rust resistance have been made in S.227 at Pant Nagar.

Crosses between the dwarf wheat material from Mexico and promising Indian varieties were made in 1963. Several of the hybrid derivatives hold great promise for <sup>a</sup> further improvement of the yield potential and quality of wheat. Through induced mutations the grain colour of Sonora 64 and Lerma Rojo has been changed from red to amber. The protein content of these varieties has also been considerably improved.

Nearly 400,000 hectares were sown with dwarf wheat varieties during the rabi season of 1966. Arrangements have been made to supply adequate quantities of fertilizers for this area. The cultivation of such non-lodging varieties in conjunction with suitable agronomic practices, is expected to help double India's wheat production within the next five years.

Development of Dwarf Rice Varieties: During 1964-65, 36.1 million hectares were under rice in India and the total production was 38.73 million tonnes. Out of the total area, nearly 13 million hectares have assured irrigation. An additional one ton per hectare can easily be produced in this area during 1967. A short and non-lodging variety is basic to getting the best out of fertilizer and water. Three of the chief limiting factors of yield in our irrigated rice growing regions are: (a) low response to nitrogen and other nutrients by the tall varieties, (b) the restriction imposed by the lodging tendency on the supply of water during the advanced stages of grain development and (c) the impossibility of adjusting the growing season in such a way that it synchronizes with natural lower temperature and sunny days which are conducive for efficient . . .

efficient photosynthesis and good grain development.

More than 30 per cent increase in grain yield has been found by a change in planting time in some varieties. The monsoon season when rice is widely grown in India is unfortunately the most unsuitable for grain production. Even if high doses of fertilizers are applied, the reduced photosynthesis caused by cloudy skies limits their use by the plant, since carbohydrate reserves are essential for nitrogen use. The discovery of a dwarf, erect-leaf and photoinensitive type of rice in Taiwan called Dee-gee-woo-gen was hence an important landmark in the yield history of indica rices.

Tests conducted in different parts of the country have shown that both Taichung Native-1 and IR-8, which are dwarf and non-lodging varieties are capable of yielding six to eight tonnes per hectare when grown under proper management. Many short-strawed, photoinensitive varieties will shortly be ready for release from the hybrids of adapted Indian varieties and Dee-gee-woo-gen, Taichung Native-1 and IR-8 already made in India. A dwarf Basmati variety of rice is being developed at the I.A.R.I. This would help to double the yield of the Basmati varieties which are grown now.

Powerful research tools are available which can help to rectify some of the prominent defects of the high yielding varieties like Taichung Native-1, Taichung-65 and Tainan-3. Through the treatment of seeds of these varieties with physical mutagens like X-rays and gamma rays and chemical mutagens like ethy-methane-sulphonate, resistance to bacterial blight has been induced in Taichung Native-1. Similarly non-sticky grains have been produced in Taichung-65. These new varieties,

new varieties, if cultivated with adequate fertilizers and pest and disease control, would help us to increase rice production by at least an additional 10 million tonnes during 1967 in the 13 billion hectares of rice land with assured irrigation.

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