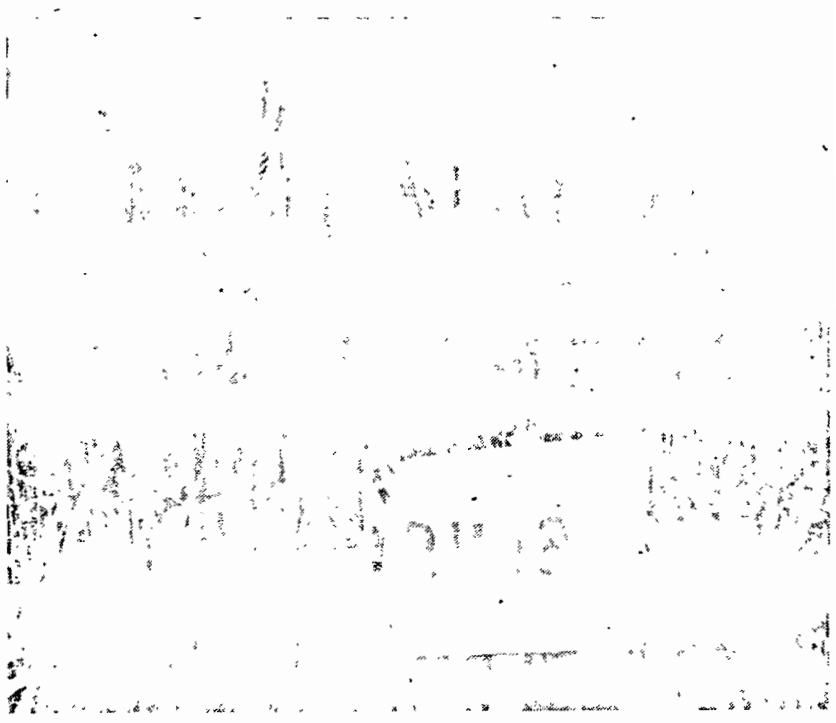
NEW HORIZONS IN WHEAT PRODUCTION

D. S. ATHWAL
N. E. BORLAUG



The authors are the two very distinguished plant breeders who have been responsible for introducing high-yielding dwarf varieties of wheat, Dr. Borlaug in Mexico and Dr. Athwal in Punjab.

Dr. N. E. Borlaug is the Director for Wheat Improvement, International Maize and Wheat Improvement Centre in Mexico. He is the father of the dwarf Mexican wheats which have revolutionised wheat production in the world.

Dr. D. S. Athwal is the Professor & Head of Plant Breeding Department at the Punjab Agricultural University, Ludhiana, who is the winner of the "Shanti Swarup Bhatnagar Memorial Award" and a Gold Medal from the Punjab farmers in recognition of his research on the improvement of bajra and wheat crop.

—Editor

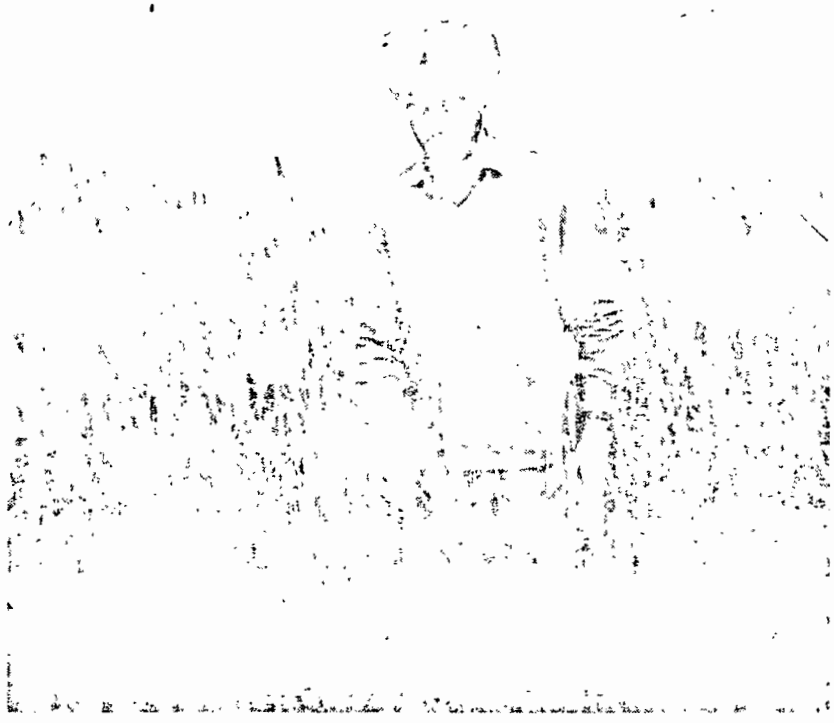
IN RECENT years, the Punjab farmers have shown more and more of inclination to the use of fertilizers to raise their levels of production. But since the wheats of this area are tall growing, the application of high doses of nitrogenous fertilizers frequently results in lodging with consequent reduction in yields. The response of these varieties is limited to 25 or 30 kg. of nitrogen per acre which results in a maximum yield of about 1,500 kg. per acre. For securing higher yields, the variety has been the limiting factor.

A similar situation existed in Mexico in 1954 when the average yield per acre there, was comparable with the present yield in the Punjab. In 1964, however, the wheat yield per acre in Mexico averaged at 1,053 kg. an increase of more than 150 per cent. Mexico is now exporting large quantities of wheat every year.

EVOLUTION OF DWARF WHEATS

The most important single factor which led to this revolution in wheat production in Mexico was the development and release of dwarf varieties which were capable of responding to high doses of fertilizers. One of the authors, N. E. Borlaug was privileged to initiate the wheat improvement research which ultimately led to the development of dwarf Mexican wheats. A similar revolution in wheat production can be accomplished in India, Punjab in particular. And a beginning in this direction has been made by the cultivation of Mexican wheats with the application of high doses of fertilizers.

In November 1963, Mexican wheat material comprising of four commercial wheats and about 150 advance generation lines of crosses was made available for studies under Indian conditions at the Indian Agricultural Research Institute, New Delhi and the Punjab Agricultural University, Ludhiana. One of the Mexican wheats, Lerma Rojo 64, was found to be suitable for cultivation under high fertility conditions in Punjab and it yielded about 30 per cent higher than the best Punjab wheats C306 and C273. It gave good performance in some other wheat growing states also. Subsequently, the Government of India imported large quantities of its seed from Mexico and distributed for general cultivation with a view to raise the low level of production.

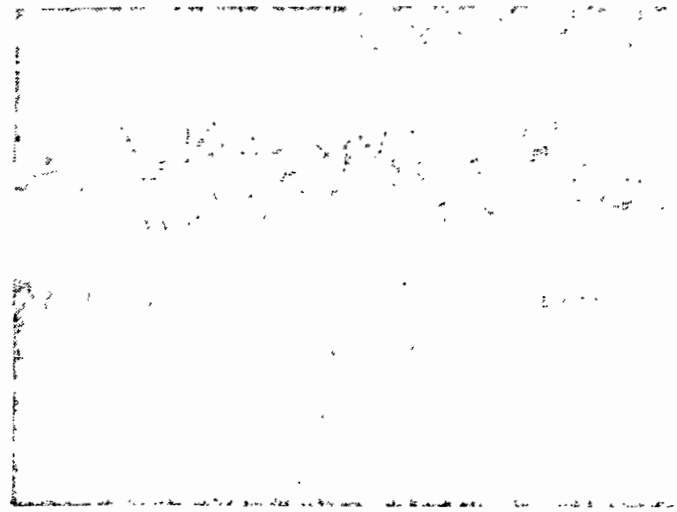


One of the demonstration plots of PV-18 grown by farmers in 1965-66

DEVELOPMENT OF RED GRAIN PV-18

A critical assessment of the advance generation lines of crosses grown at Ludhiana during 1963-64 showed that some of these were even better than Lerma Rojo 64. One of the lines which was picked up for immediate selection has been named as PV-18. This wheat variety made a start with only two kilograms of seed which was all that was available from the harvest of 1963-64. Some of this seed was sent to Lahaul Valley where wheat can be successfully grown during summer. The seed thus multiplied was utilized for yield trials as well as for further multiplication in *rabi* of 1964-65 in the plains. On the basis of trials conducted at four different research stations. PV-18 yielded 10 per cent higher than the Mexican wheat Lerma Rojo 64 and 42.0 per cent higher than the best Punjab wheat C306 on the average. Its per acre yield was 2,118 kg. as compared with 1,926 kg. of Lerma Rojo 64 and 1,492 kg. of C306. In a small demonstration plot at the University Farm, Ludhiana, PV-18 recorded an estimated yield of 3.2 tons per acre. Yield tests were continued on this variety at research station in 1965-66 to confirm its superiority. On the average of this trial at seven different places in the Punjab, it again outyielded Lerma Rojo 64 and C306 by 22.8 per cent and 42.5 per cent. respectively. Simultaneously it was decided to distribute seed to selected farmers in order to convince them regarding the yield potential of PV-18 and also to test its performance on the cultivators' fields which is an essential step in the release of new crop strains. Eighty farmers were selected from hundred who were anxious to try this strain. The selected farmers from all over the state were invited to receive $2\frac{1}{2}$ kg. seed-packets along with detailed instructions on cultivation practices to be followed. The seed was meant for sowing a plot of 1/16 acre. Major portion of the available seed was reserved for further multiplication.

Most farmers raised excellent plots comparing the performance of PV-18 with Mexican Lerma Rojo 64 and Punjab wheats C306 or C273 and maintained complete records of the application of fertilizers, irrigation water and other treatments. These plots were visited by the research and extension staff for advice. This method of testing the performance of a new strain on farmers' fields proved a great success and yielded convincing information in a short time. The actual results received from 51 farmers showed that on the average. PV-18 was found to yield 29.1 per cent higher than Lerma Rojo and 60.4 per cent higher than C306. The plots were generally fertilized at the rate of about 55 to 60 kg. N, 28 kg. P and 24 to 28 kg. K per acre though there were some variations. The yield of most of these plots was close to 2.5 to 3.0 tons per acre and three of the farmers secured yields higher than 3.5 tons per acre. These are comparable with the highest yields reported from other countries. One acre-plot at the University Farm, Ludhiana. yielded 2.8 tons and a yield of 3.1 tons was obtained from one of



Demonstration plots of PV-18 were visited by thousands of farmers

the 30 acres sown with PV-18 at the Nucleus Seed Farm of the University at Naraingarh.

PV-18 PROVES ITSELF

The plots of PV-18 grown on the cultivators' fields and research stations during 1965-66 were visited by thousands of interested farmers who could not get its seed due to short supply. Many farmers who grew small areas with PV-18 were offered unusually high prices for seed, which ranged five to eight times the normal price of wheat.

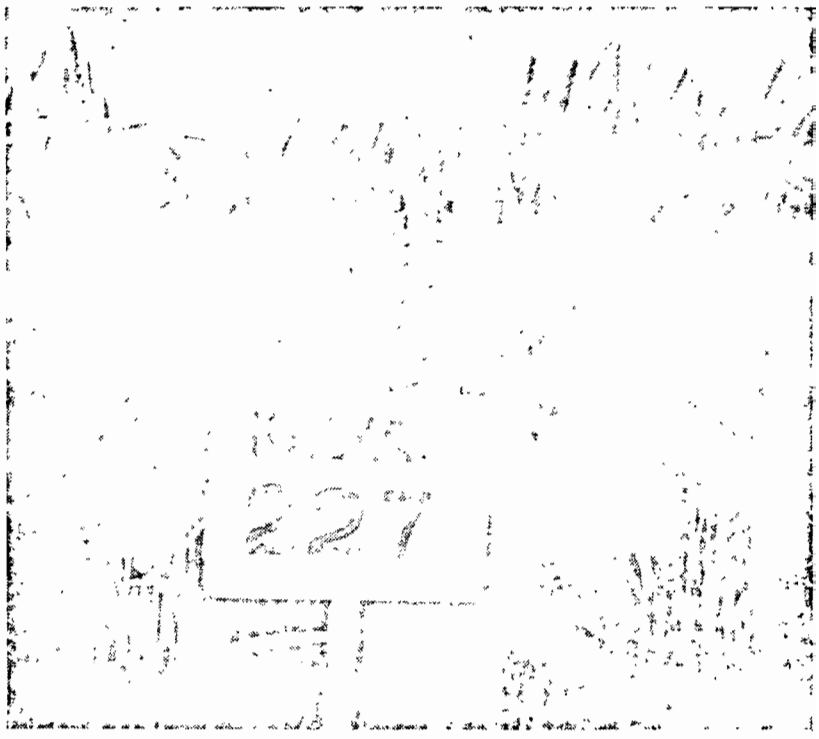
PV-18 has a grain of red colour which is not very popular with Punjab consumers but it has been proved that the dislike for reddish colour is without any scientific basis. The results of quality tests and chemical analysis conducted at the Indian Agricultural Research Institute have shown that this wheat is not inferior to amber grain Punjab wheats. Its *chapaties* are as good as those of C 306 except that the colour is slightly reddish.

PV-18 as a crop has several desirable characteristics. It possesses a high degree of resistance to rusts and loose smut. Even with artificial inoculation PV-18 showed complete resistance to loose smut which makes it the first wheat variety incorporating resistance to loose smut that has been released in the Punjab. It has good tillering capacity and impressive head. The average number of grains per head is approximately 65 as compared to 50 in most of the Indian wheats. The larger number of grains appears to be an important component of its high yields potential. It is highly resistant to lodging. The average plant height is three feet as compared to four feet of Lerma Rojo and five feet of Punjab wheats. In spite of its short stature, the straw yield of PV-18 is equal to local tall wheats on account of its thicker stem. In palatability its *bhoosa* has been found to be satisfactory to cattle. It was released for general cultivation under high fertility conditions in June 1966.

The results of All-India Co-ordinated trials under high fertility conducted during 1965-66 showed that it was the highest yielding strain in U.P., Punjab and Delhi. Nearly 60 tons of its seed was produced during 1965-66 and has been distributed. The farmers who were given its seed last year properly have produced an additional 15 tons. It is thus expected that PV-18 would be grown on an area of about 2,000 acres in the Punjab during 1966-67. This would give enough seed for sowing 100,000 acres in the following season. PV-18 gives higher yields when sown from end of October to middle of November but much higher yields than C 306 and C 273 have been obtained even when the sowing was done late in November or early in December. It should be possible to secure a yield of two tons per acre even if it is sown as late as 5th of December in the central and submontane districts provided the field is well-fertilized. In order to get good germination, it is necessary to sow the seed at a depth of 2 to $2\frac{1}{2}$" in soils with adequate moisture in the upper layers. Normally, PV-18 should be fertilized at the rate of 60 kg. N, 25 kg. P and 25 kg. K per acre and irrigated six times. The entire P and K and at least half of the N should be applied before sowing. Give the first irrigation about three weeks after sowing and add nitrogenous fertilizer at sowing and additional dose with first irrigation.

AMBER GRAIN KALYAN 227

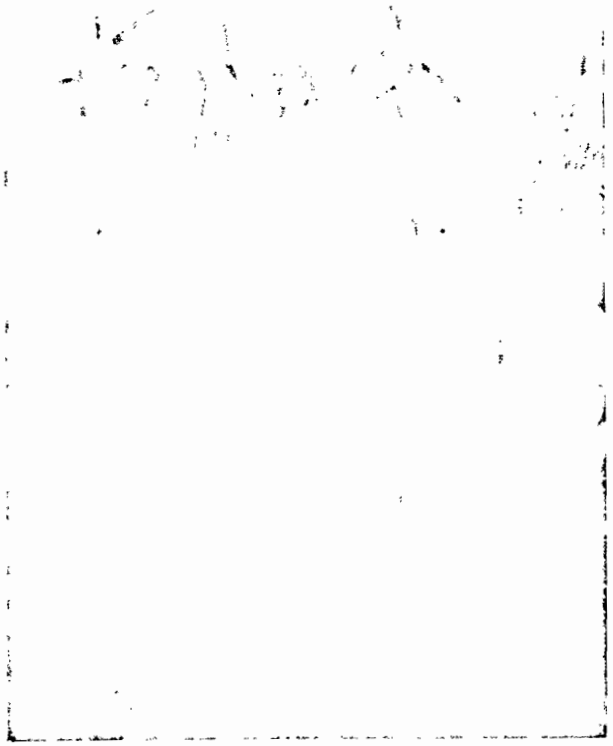
Another dwarf strain with the same yield potential as PV-18 but having amber grains, almost like



New dwarf strain Kalyan 227 which combines high yield with amber grains and will excel PV-18. It will ease our food situation in the near future

Punjab wheats, has also been developed through selection from a sister line of PV-18 originally obtained from Mexico. This strain has been designated as Kalyan 227 at Ludhiana. The original unselected line which shows susceptibility to brown rust, was included in international yield trials during the last two years. On the average of 17 trials in 1964-65 and 14 trials in 1965-66 conducted in important wheat growing countries of Asia and Africa, it gave higher yield than all other varieties. It yielded 20.0 to 30.0 per cent more than the locally developed varieties in different countries. In yield trials at six research stations in the Punjab during 1965-66, Kalyan 227 yielded almost equal to PV-18, and 17.0 per cent higher than Lerma Rojo and 38.2 per cent higher than C 306. Its straw yield was equal to PV-18 and C 306. Small quantities of seed of Kalyan 227 have been distributed for trials on cultivators' fields in the Punjab during 1966-67. Simultaneously trials at research stations will be continued. If the results obtained in 1966-67, season confirm the superiority of Kalyan 227, this strain will be released to the growers before the sowing season of 1967-68. Meanwhile arrangements have been made to multiply its seed in adequate quantities.

While reporting the development and performance of PV-18 and Kalyan 227, we wish to acknowledge the contribution of many individuals and institutions connected with this work at various stages. Several Mexican research workers in the National Institute of Agricultural Research were associated in the initial stages of development of wheat material sent to India. The All-India Co-ordinated Wheat Improvement Scheme at the Indian Agricultural Research Institute played an important role in the evaluation of PV-18 and other material. Many staff members of the Department of Plant Breeding and Directorate of Extension Education at the Punjab Agricultural University provided valuable assistance in the conduct of yield trials and multiplication of seed.



A wheat of the future—one of the new lines developed by crossing PV-18 with a Punjab Wheat. It possesses all the desirable characters of the two parents and will make a new era in wheat cultivation

Research Note

THREE CROPS WITH EASE

There is now a serious talk in the agricultural hierarchy to have three crops in a year from all such lands where ample irrigation water and fertilizer sources are available. In Hoshiarpur and Gurdaspur districts, there is already a practice to grow three crops by sowing *sathi maize*, which is so called because it is ready in about 60 days' time after the harvesting of wheat and before planting of rice. It may be possible to introduce this practice in other places too.

It may be of interest to our readers that a forgotten millet known as *cheena* has also given encouraging results at the Demonstration-cum-Training Farm at PAU, Ludhiana. It can be sown at the rate of 4 to 5 kg. per acre by broadcast after harvesting wheat. Its straw can be fed to cattle and grain to poultry birds. It is also eaten by human beings. *Cheena* can be grown in rotation as *cheena*-rice-wheat or *cheena*-hybrid maize-wheat.