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Proceedings of an international symposium
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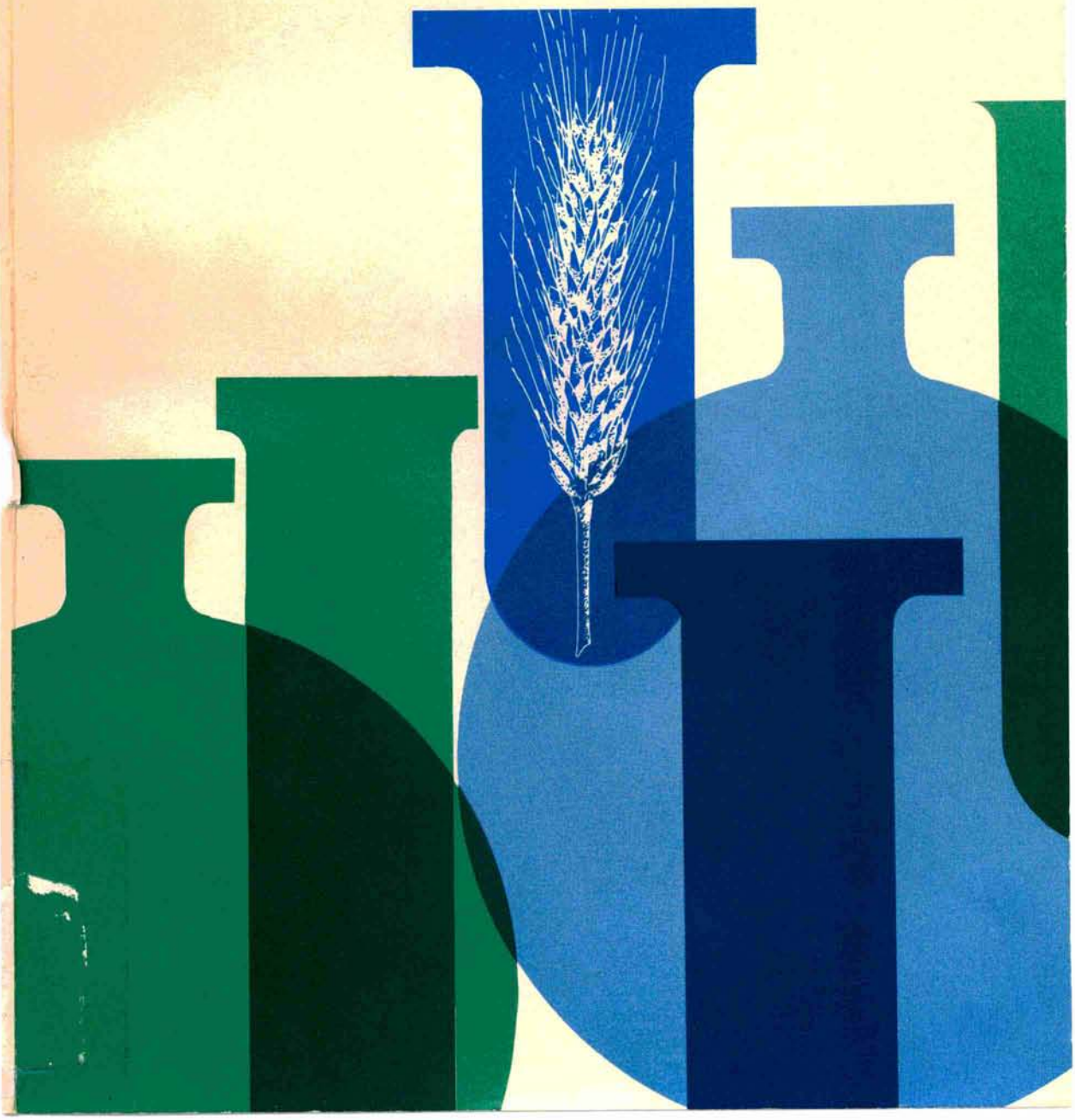
Editors: Reginald MacIntyre/Marilyn Campbell



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*The views expressed in this publication are those of the individual author(s) and do not necessarily represent the views of the International Development Research Centre.

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Prospects of Triticale as a Commercial Crop in India

J. P. SRIVASTAVA

G. B. Pant University of Agriculture and Technology
Pantnagar, India

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Abstract India is very interested in adopting triticale as a new cereal crop, particularly in the rain-fed areas where wheat does not yield well. Early triticale lines were tested at low fertility but did not outyield wheat under rain-fed conditions. Later trials with improved CIMMYT lines planted at higher elevations but in low fertility conditions (pH 6.5) gave higher yields than wheat planted in the same area. The triticale showed high resistance to *Septoria* and powdery mildew and no ergot infection was observed. Observations so far indicate that triticale can be grown as a profitable cereal crop in the Himalayan region of India.

Résumé Les autorités indiennes accorde le plus grand intérêt à l'idée d'adopter le triticale comme nouvelle céréale cultivée, en particulier dans les régions non irriguées où le blé ne pousse pas très bien. De jeunes lignées de triticale ont fait l'objet d'essais en terrains peu fertiles mais elles n'ont pas donné un rendement supérieur à ceux du blé en culture sèche. Les essais ultérieurs effectués avec des lignées améliorées du CIMMYT semées en altitude mais dans des sols à caractère peu fertile (pH 6.5) ont donné des rendements supérieurs à ceux du blé dans ces mêmes régions. Le triticale a manifesté une forte résistance à *Septoria* et à l'oïdium, et l'on n'a pas constaté la présence d'ergot. Les observations effectuées jusqu'ici indiquent que le triticale peut constituer une culture céréalière profitable dans les régions hémalayennes.

INDIA has been interested in the progress being made in research on triticale as a commercial cereal crop, especially in those areas where wheat does not yield well. As it was expected that triticale might withstand the moisture stress and give reasonable yields in the vast rain-fed areas of this country, the early triticale lines developed in Canada and some of the European countries were tried at some locations in the early and mid-1960's. With the reported progress made in improving the grain yield and quality as well as the agronomic characters of triticale, a number of research centres started work on this crop, notably Delhi, Indore, Ludhiana, and Pantnagar in the late 1960's. The triticale lines obtained from different sources, especially CIMMYT, were tested in rain-fed and irrigated conditions. The best lines, on the basis of these tests, were put together and in 1970–71 they were tested at 11 locations along with Kalyansona and the best local checks. The trial was conducted at low fertility (40 kg N, 30 kg P_2O_5, and 20 kg K_2O per hectare)

and rain-fed conditions. The trials were spread in the states of Uttar Pradesh, Himachal Pradesh, Gujarat, Madhya Pradesh, Bihar, Rajasthan, Haryana, Punjab, and Delhi. The triticale lines were mostly Armadillo selections, Bronco 90, Bruin 46, and a few local selections. The overall average yields obtained in this trial are presented in Table 1.

TABLE 1. Coordinated triticale trial (1970–71), overall average yield of 11 locations.

	Q/ha
Triticale lines	14.2
Kalyansona (bread wheat)	19.3
Local improved rain-fed variety of bread wheat	19.2

The results obtained from this trial indicated that the triticale lines available at that time were not better yielding than wheat under rain-fed conditions in India.

At Pantnagar, we have been cooperating with CIMMYT's triticale program since 1967. Several selections were made from the lines and segregating populations obtained from CIMMYT and the selected population was planted in 1968 at several locations in the Himalayan region as observation rows with wheat. The triticale lines appeared to grow very well as compared to wheat and barley. Because of their superior performance, they were planted at eight locations in 1969, as observation rows at heights ranging from 1372 to 3049 m (4500–10,000 ft). Again some of the lines appeared to be very promising. In 1970, several selected lines of Armadillo, Bronco 90, and Bruin were planted at an elevation of 2378 m (7800 ft) along with wheat and triticale outyielded wheat. The observation rows were planted in low fertility conditions and the pH was below 6.5 in almost all instances. The triticale lines showed good resistance to *Septoria* and powdery mildew and no ergot infection was observed anywhere.

Dr Chauhan, the triticale breeder at Pantnagar, planted triticale and wheat at several locations in the central Himalayan region during 1971–72 and 1972–73, and at all the locations the triticale lines appeared to do better. He observed that Arm P.M. 116, Arm P.M. 112, Arm P.P.V. 13, and Arm P.M. 114 gave yields of over 4 tons per hectare whereas Kalyansona gave an yield of 2.3 tons per hectare. Our observations so far indicate that the triticale lines could profitably be grown as a cereal crop in the Himalayan region.

To see the performance and adaptability of selected triticale lines in the rain-fed plains of India, we selected six best Armadillo lines, Bronco 90, and a Delhi selection, and, along with Kalyansona (an improved dryland common wheat variety C-306), durum wheat Jori 69, and improved barley variety Ratna, planted at four widely located stations at Durgapura, Powarkheda, Pantnagar, and Pusa. The average yield obtained is summarized in Table 2.

The trial at Durgapura was irrigated. The

TABLE 2. Grain yield, *Q/ha.*

	Durgapura	Pantnagar	Powarkheda	Pusa	Mean
Triticales	16.0	24.8	7.1	9.8	14.4
Kalyansona (common wheat)	25.3	44.8	15.6	16.8	25.6
C-306 (common wheat)	20.1	34.2	20.5	10.5	21.3
Jori C-69 (durum wheat)	16.6	42.5	13.5	11.7	21.1
Ratna (barley)	27.2	34.2	20.1	13.8	23.8

results indicate that these lines do not have yield superiority in the moisture stress plains in India.

Observations taken for plant and grain characteristics are presented in Tables 3–5.

The results indicated that triticale lines tested in these trials were poorer in initial plant stand and shy in tillering compared to wheat and barley. Grain number in spikes was lower as compared to Kalyansona and the seed setting was less than in 70% of the florets. The grains were shrivelled, and the protein content in the grains was not significantly higher compared to Kalyansona. It appears that special effort is required to evolve triticale lines capable of withstanding prolonged soil moisture stress, atmospheric drought, and high temperature common in the rain-fed areas of India. Rye and wheat strains being grown under such conditions may be used to synthesize triticale lines for the above-mentioned conditions.

Under irrigated and high fertility conditions, the performance of some of the triticale lines has been encouraging. In International Triticale Yield Nursery trials (1972–73) conducted at Delhi, Joshi et al. (1973) reported that some of the triticale lines outyielded

TABLE 3. Number of tillers per running meter and number of florets per main earhead.

	Durgapura	Pantnagar	Powarkheda	Pusa	Mean
			Tillers/running meter		
Triticales	72.64	78.89	49.61	48.42	62.39
Kalyansona	84.63	101.50	65.63	71.50	80.82
C-306	90.63	95.00	59.25	56.25	75.28
Jori C-69	77.25	74.63	48.88	49.50	62.57
Ratna	114.63	110.88	72.75	21.37	94.91
			Florets/main earhead		
Triticales	69.75	64.73	65.75	47.18	61.85
Kalyansona	75.45	66.70	56.25	50.20	62.15
C-306	52.95	48.40	60.00	41.95	50.83
Jori C-69	60.45	59.40	56.10	33.47	52.36
Ratna	56.35	49.00	57.75	37.45	50.14

TABLE 4. Number of grains per main earhead and fertility (%).

	Durgapura	Pantnagar	Powarkheda	Pusa	Mean
			Grains/main earhead		
Triticales	44.73	47.28	39.25	31.65	40.73
Kalyansona	59.30	56.75	46.55	39.17	50.44
C-306	45.35	41.88	51.50	34.75	43.37
Jori C-69	43.10	41.93	39.35	19.80	36.05
Ratna	49.60	43.85	52.20	33.25	44.73
			Fertility (%)		
Triticales	62.97	73.57	59.02	66.77	66.33
Kalyansona	77.02	80.42	79.75	77.72	78.73
C-306	85.73	84.10	85.15	81.86	84.21
Jori C-69	70.64	70.57	73.11	55.68	67.50
Ratna	86.35	89.33	90.36	88.11	89.54

TABLE 5. 1000 Kernel weight and protein (%).

	Durgapura	Pantnagar	Powarkheda	Pusa	Mean
Triticales	29.92	40.33	37.55	34.65	35.61
Kalyansona	31.22	36.28	38.05	35.17	35.18
C-306	37.99	46.74	45.77	38.04	43.14
Jori C-69	39.45	58.35	56.35	41.04	48.79
Ratna	41.73	46.64	47.84	41.65	44.46
			Protein (%)		
Triticales	14.60	14.82	16.10	11.38	14.23
Kalyansona	13.91	14.41	15.00	12.22	13.88
C-306	11.28	11.42	12.15	9.25	11.03
Jori C-69	8.71	13.49	14.00	12.79	12.25
Ratna	7.97	9.63	8.89	6.65	8.29

best common wheat varieties. The performances of the best five entries in this trial are presented in Table 6.

The same nursery was planted at Ludhiana, under high fertility and irrigated conditions and Gill et al. (1973) reported that a number of triticale entries outyielded bread wheat variety Kalyansona. The yields obtained at Ludhiana are presented in Table 7.

Kalyansona was heavily infected by brown rust. These and other results obtained from irrigated and well-fertilized trials indicate that some of the triticale lines hold the promise of performing as well as, or even better than, the best bread wheat varieties, at least in those areas where they have been listed.

The primary use of triticale in the Indian subcontinent and particularly in the Himalayan region will be in the form of "chapati." Extensive tests were done to compare chapati-making properties of triticale flour with that of wheat (Fig. 1). The Armadillo lines were compared with wheat variety C-306. The triticale flour from the selected Armadillo lines was whiter as compared to C-306 and to some extent behaved like soft wheat flour (Fig. 2). However, it absorbed less water but the chapati puffing quality was comparable and was sweeter than that made from C-306. The triticale chapati was slightly leathery as compared to that of C-306. The triticale and wheat flour was distributed to a number of families for comments on the chapati-making quality. The laboratory and consumer tests indicated that triticale flour is acceptable for chapati making.

Encouraged by the performance of triticale at limited locations in the central Himalayan region, we wish to test the best available triticale line in the western and central Himalayas.

TABLE 6. Performance of best five entries in the International Triticale Yield Nursery (1972–73) at Delhi.

Strain	Yield (*Q/ha*)
Maya II Arm-S	39.2
Inia Arm-S	36.3
Inia-Gra-Arm	36.0
Pitic (common wheat)	35.3
Kalyansona (common wheat)	34.4

TABLE 7. Performance of some of the triticale strains for grain yield in the International Triticale Yield Nursery at Ludhiana (1972–73).

Strain	Yield (*Q/ha*)
Cinnamon	58.0
Arm-S (S. No. 12)	55.1
Inia-Arm-S (S. No. 7)	52.9
Arm-S 105	52.2
Inia-Gra-Arm-S	50.7
Inia-Arm-S (S. No. 17)	50.7
Arm-S (S. No. 11)	49.3
Tcl Maya II Arm-S	48.5
Kalyansona	32.6

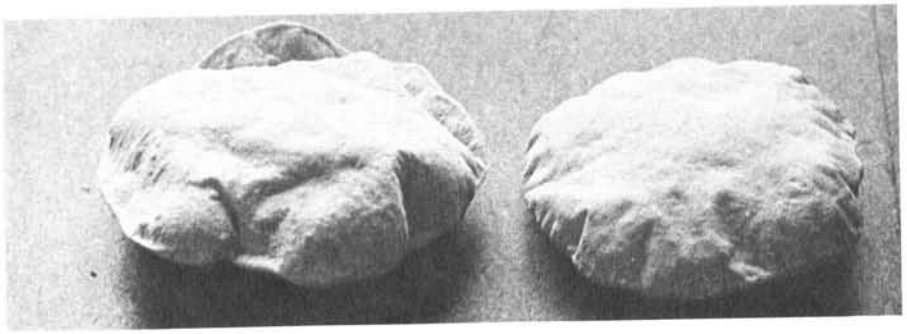

FIG. 1. Chapati made of triticale (*left*) and wheat (*right*).

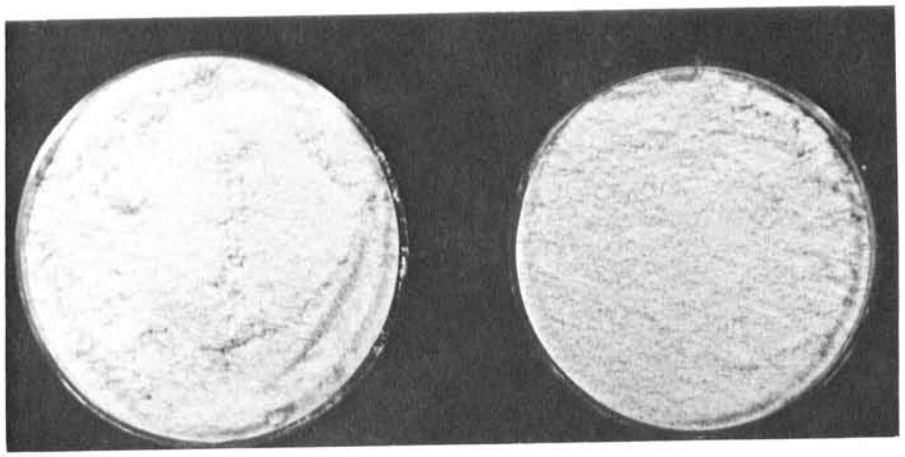

FIG. 2. Triticale flour (*right*) from the selected triticale lines is better in appearance than the wheat flour (*left*).

Approximate areas of the Himalayan region including Afghanistan where triticale can be tried as a commercial crop for human consumption are given below:

Region	*Population*
Western Himalayas	18,913,173
Central Himalayas	12,374,185
Outer Himalayas including Afghanistan	14,000,000

The different Himalayan regions will include the following areas:

Western Himalayas
- (I) Punch & Jammu
- (II) Pir Punjal range
- (III) Vale of Kashmir
- (IV) Main Himalayan mass
- (V) Gilgil-Hunza
- (VI) Laddakh
- (VII) Karakoram

Central Himalayas
- (I) Himachal Pradesh
- (II) U.P. Hills
- (III) Nepal
- (IV) Parts of Tibetan Plateau

Eastern Himalayas
- (I) Kosi Basin–Eastern Nepal
- (II) Darjeeling–Sikkim
- (III) Bhutan & Assam Himalayas

In the Western Himalayas total precipitation is low and it increases eastwards. Similarly temperature is lower in the Western Himalayas and it decreases eastwards. In the Western Himalayas the precipitation is higher in January–March than in monsoon months

(June–September), which means winter rains during crop growth. The reverse is true in the Eastern Himalayas. In the Valley of Kashmir annual rainfall is 25 inches whereas in Ladakh it is 3–4 inches. In Himachal it is 60 inches, in U.P. Hills 70 inches, and in the Eastern Himalayas it is 125 inches. The soil is predominantly acidic (pH ranging from 4.5 to 6.5). In a few areas the soil is alkaline.

This whole area provides a special challenge with respect to providing food as it is a food-deficient area. The people are poor and nutritionally deficient. The staple food is millets, maize, wheat, barley, and rice. The soil will remain acidic for years to come, the fertilizer availability will remain scarce, and the crop will be grown under rain-fed conditions. The advance wheat production technology cannot be adopted in large areas except in the valleys. There is a definite need for a cereal that can give reasonable yields under these trying conditions without demanding sophisticated production technology and higher inputs, and as far as I can see triticale fits the requirement.

The ergot problem needs to be studied carefully in this area. The well-filled grains of improved triticale lines may remove the problem of early viability loss and poor germination. There is need for extensive tests with the best triticale lines in the whole area extending from Afghanistan to Nepal. At the same time, seed of superior lines needs to be multiplied somewhere in this area, so that in a year or so seed of these varieties can be distributed to the farmers for commercial evaluation.

There is very little information regarding suitable cultivation practices for triticale in the hills. We plan to conduct agronomic trials in these areas this year to give some guidelines in this respect.

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