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Future Role of Triticales in Agriculture

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Abstract A major milestone in the improvement of triticale occurred in 1964 when Dr Borlaug launched the triticale program at CIMMYT. The speed with which many of the difficult problems connected with the first triticales were at least partially resolved has been very impressive. The improvement in both fertility and seed density, and the broadening of the genic base have led to a rapid increase in yields. Triticale yields at CIANO, Tulelake, California, and Winnipeg, Manitoba, in 1973 were greater than the top wheats grown in these areas. Over the next 15 years, yields of triticale will improve much more rapidly than those of wheat and should plateau at a level approximately 50% higher than those of wheat. At that time, triticale will have begun to seriously compete with the bread wheats as one of the world's most important food crops.

Résumé L'amélioration du triticale a progressé à pas de géants depuis qu’en 1964 Monsieur Borlaug a lancé au CIMMYT le programme sur le triticale. Il est impressionnant de constater la rapidité avec laquelle un grand nombre des problèmes difficiles inhérents aux premiers triticales ont été au moins partiellement résolus. L'amélioration tant de la fertilité que de la densité des épis, accompagnée d'un élargissement des bases génétiques, se sont traduits par une augmentation rapide des rendements. Les rendements pour 1973 du triticale du CIANO, à Tulelake, en Californie, ainsi qu'à Winnipeg, au Manitoba, ont été supérieurs à ceux des meilleurs blés cultivés dans ces régions. Au cours des 15 années à venir, les rendements des triticales augmenteront beaucoup plus rapidement que ceux du blé et devraient se stabiliser à un niveau supérieur d'environ 50% aux rendements du blé. Le triticale aura alors commencé à rivaliser très sérieusement avec les blés panifiables en tant que l'une des cultures vivrières les plus importantes du monde.

When I received the invitation to attend this symposium and to provide the concluding paper on the topic “The Future Role of Triticales in Agriculture,” my better judgement told me that I should not accept. Having seen the imposing list of invited speakers — experts actively working on the improvement of triticale — I knew full well that, collectively, they would thoroughly cover all aspects of triticale synthesis and improvement, from the historical beginnings to an optimistic future and that there would be little left to say.

The excellent addresses and discussions we
have listened to have confirmed my earlier convictions. Most speakers, while recognizing inherent weaknesses within the new species, were highly optimistic about its future. The collective optimism was probably best expressed by Dr Finlay when he said something to the effect that in the last 10 years the triticale species has made up for at least 20,000 evolutionary years of the 30,000 years of evolution experienced by the bread wheats.

Nevertheless, I accepted the invitation to speak, not because I could add anything new, but selfishly to hear of all the exciting things that were going on. If today I am to speculate on the future role of triticale in agriculture, I would like to do so largely on the basis of my personal experiences with the crop during the last 19 years and to supplement this with what I have heard or read. A look at the future is most safely made if based on past experience, and thus a brief historical review is called for.

It was only 19 years ago that I saw for the first time the hexaploid triticale. In 1954 we had obtained sufficient seed from Dr O'Mara to plant a single 5-ft row of the ABR combination in our wheat introduction nursery. I still vividly recall seeing the new species shortly after it headed and flowered. The vegetative vigor and the large spikes of the triticale were most impressive, and far outshadowed in appearance the surrounding well-adapted bread wheats and durums. It required very little imagination to visualize in this species a potential new cereal crop that could be far more productive than the bread wheats.

Coincident with our growing the hexaploid species for the first time was the establishment of the Rosner Research Chair in our Faculty by the Samuel and Saidye Bronfman Family Foundation, which made it possible to initiate the triticale program at the University of Manitoba, first under the direction of Dr Jenkins, and subsequently so ably carried on by Dr Larter.

I also recall showing that first 5-ft row of triticale to the late Dr W. J. Parker, President of the Manitoba Pool Elevators, and within a week had from him a pledge of $5000.00 per year for 4 years to provide support for the triticale program that was to be initiated by the Rosner Research Chair.

By 1958 we had developed a small collection of hexaploid triticale, some of which were introduced from Japan and the USSR, and others that were synthesized at Winnipeg. In addition we had a modest collection of the Triticum and Aegilops species that were believed to be the component species of the bread wheats as well as synthesized ABD's. These were all on display for the First International Wheat Genetics Symposium.

There were two things I believed to be strikingly clear in the field display prepared for that symposium: (1) that the synthesized ABR's were far more vigorous than either of the component parent species; and (2) that the synthesized ABD's or bread wheats, although more vigorous than the Aegilops squarrosa parent, were far less vigorous than their tetraploid Triticum parents.

This led to the natural conclusion that the D genome was a poor combiner with the tetraploid wheats for productive capacity whereas the R genome was a good combiner.

I had the privilege at that symposium to speculate on the impact of the D genome, and for those of you who were not there, I would like to recall the speculations made 15 years ago with excerpts from my paper:

"If in the course of evolution — a genome other than the D had combined with the A and B — would the pattern of man's long struggle to provide adequate sustenance have been the same."

Quoting further, and admittedly out of context:

"The ABR combination is particularly impressive and as a potential crop has all the appearances of being a far more productive starch producing plant factory than the best of the present-day bread wheats. Those of you who were on the field tour on Tuesday, I am sure will agree, that this species conveys such an impression. But we all know how deceiving visual impressions may be. Will there not be a good deal of sterility? Will not grain be badly shrivelled? Will the grain produced be of poor quality?"

"These questions were answered in part this morning by Dr Riley and Dr Sanchez-Monge — and the answers were not en-
couraging. But are we to forget that in the last 50 years scientists working on the improvement of the bread wheats have virtually doubled its yielding ability in many parts of the world? Are we going to put mental stumbling blocks before us and enter the field of directing evolution to our use too slowly — too cautiously?

“We recognize in the bread wheats that there are genic differences and certainly by breeding attempt to obtain better genic combinations. We recognize that there are chromosomal differences and can become quite enthusiastic about chromosome substitution — even chromosome substitution from different species. But if we can replace one of the chromosomes of the bread wheats by a chromosome from rye — are we not entering the field of genome construction? Should it not then be feasible to replace one of the rye chromosomes by a chromosome from the D genome and improve the seed shrivelling characteristics without losing too much of the phenomenal vegetative vigor?”

The questions raised 15 years ago were certainly well covered and answered during the past 3 days.

Yield trials carried out with primary synthesized hexaploid triticales were disappointingly low and did not live up to their vegetative potential, for the obvious reasons of incomplete fertility and seed shrivelling. It was natural, therefore, for the traditionalists to overlook the potential and stay clear of working with the new species. But comparisons were always made with the best of the highly developed bread wheats and never with synthesized ABD. It simply did not occur to wheat breeders to examine the fertility of the synthesized ABD. I recall Dr Kilhara stating at a meeting in New York that in the past 30 years his group had synthesized a large number of bread wheats and had not found chromosomal stability in any of them. This had been in response to a report from Dr Muntzing that he had found excellent chromosomal stability in one of the fertile triticale lines obtained from Dr Zillinsky.

Fortunately, Dr Sanchez-Monge in Spain and Dr Kiss in Hungary continued their pioneering work on the improvement of triticale. At Winnipeg, in order to look at possible uses for triticale, seed of the triticale we had introduced from Japan was increased. This was a *Triticum persicum × Secale cereale* hexaploid. The first farm field was sown in 1961 and the farmer growing the species reported a yield considerably higher than yields obtained from surrounding wheat fields. For the next several years this primary triticale was grown under contract on more than a thousand acres annually to provide seed for testing by a distillation industry and for large-scale animal feeding trials. In each year a number of the best fields averaged 50 bushels per acre, which compared favourably with the best wheat yields in the district.

One phenomenon we noted was that the yields from large farm fields were considerably higher than those obtained from our small replicated experimental plots. We concluded that the large pollen mass over a large farm field would provide for an increase in fertility over that obtained from small plot areas.

With the release of the variety Rosner, which was a considerable improvement over the primary triticale, the contracting farmer recently reported that in his opinion, over the last 4 years Rosner was close to 25% higher in yield than the recommended varieties of wheat, Manitou and Neepawa, under comparable treatment.

A major milestone in the improvement of triticale occurred in 1964 when Dr Borlaug launched the triticale program at CIMMYT. This was a milestone because at least in North America, it brought an aura of respectability to triticale research. Far more important, it expanded tremendously the total research effort, and it brought into play the vast fund of experience that the CIMMYT group had attained in improving the bread wheats.

The speed with which many of the difficult problems were at least partially resolved was nothing short of phenomenal. The improvement in both fertility and seed density, and the broadening of the genic base led to a rapid increase in yields.

By 1971, Zillinsky and Borlaug, in their research Bulletin #17, reported as follows:
“Although average yields in Triticale have increased substantially during the past two years, they are not yet competitive with the best commercial dwarf Mexican varieties.”

But the data they provided showed that at El Batan and Toluca in 1969 the top-yielding triticale outyielded the top-yielding wheat variety by 327 kg/ha. Similarly, at Toluca in 1970 the top triticale outyielded the top wheat by 1137 kg/ha, and at El Batan the top triticale outyielded the top wheat by 407 kg/ha.

Before either Dr Borlaug or Dr Zillinsky take me to task for not providing some qualifying statements, I should add that at El Batan they suspected that wheat suffered more than triticale from residual effects of atrazine, and also that only half the recommended rates of fertilizer was used in order that the triticales would not lodge.

Since coming to this symposium I have seen the 1973 yield results at CIANO where the full recommended rates of fertilizers were used. Thirty-one strains of triticale outyielded the highest yielding bread wheat and durum wheat controls, and some of these by a considerable margin: in exp. 2 by 1069 kg/ha; in exp. 3 by 1107 kg/ha; in exp. 5 by 1125 kg/ha; and in exp. 7 by 1198 kg/ha. The top triticale yielded 8352 kg/ha.

I was also shown the data on the performance of triticale selections at Tulelake, California, for 1973. The top triticale yielded 9890 kg/ha as compared with 8170 kg/ha for the top wheat; or, in other words, the top triticale was 21% higher than the top wheat.

At Winnipeg in 1973, the top-yielding triticale outyielded our highest yielding feed wheat Glenlea by 18% and the variety Rosner by 70%.

I have focussed attention on advances in yield, because unless the new cereal crop will produce more grain on the existing land surface of the earth than competitive cereals and in particular, wheat, it is highly unlikely that it would have a future. The question of acceptable quality of the grain need not be repeated here, other than to re-emphasize the consensus reports that it should be able to replace wheat either as a food or a feed and because of its higher lysine content, be nutritionally superior.

Triticale is already being grown commercially in Spain, and its use will expand as the breeding program expands. This is equally true in Hungary. Dr Kiss clearly indicated why triticale is being grown commercially in his country.

The striking performance of triticale in Ethiopia reported by Mr Hailu Gebremariam suggests that the current introductions he tested are ready to be grown at the farm level.

Dr Srivastava provided excellent evidence for the growing of triticale in parts of the Himalayas, and his work should be supported. More breeding work is required before triticale will be ready for release in other parts of India.

But I have rambled long enough. In my opinion, over the next 15 years, yields of triticale will improve much more rapidly than those of wheat and should plateau at a level approximately 50% higher than those of wheat. This is no idle speculation. Surely the phenomenal improvement that has taken place in triticale in 10 short years, starting from a very narrow genetic base, and on a very modest scale as compared with the bread wheats, should clearly indicate that with rapidly expanding programs and a quickly widening genetic base, with improved fertility and seed density, with improving world wide cooperation, the improvements over the next 15 years will greatly surpass all improvements that so far have been attained.

In 15 years, triticale will have begun to seriously compete with the bread wheats as one of the world’s most important food crops. This is what I expect to see reported at a triticale symposium to be held in 1988.