Development of Triticale

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Wheat (*Triticum aestivum* L.) produces more grain per year than any other cereal crop, with only rice (*Oryza sativa* L.) coming close. Wheat is primarily used as food and provides more nutrition to humans than any other food source. Throughout recorded history, it has been a staple food. Wheat was grown as a food crop as early as 8000 to 10000 B.C., according to evidence. The earliest wheat varieties were most likely non-free threshing emmer wheat’s. Wheat's role as livestock feed has always been less important than its role as human food. Direct use of wheat as livestock feed has traditionally been limited to times of surplus in developed countries. However, as a by-product of modem milling, as much as 28% of the wheat grain, mainly bran and shorts, finds its way into mixed livestock feeds **(Inglett, 1974).**

Wheat is the most adaptable cereal in terms of diet. Wheat is used to make a wide range of products, with baked leavened bread serving as the main product in developed nations while unleavened baked bread serves as the more prevalent form in developing nations. Pastries such sweet rolls, cakes, doughnuts, cookies, pie crust, and other well-liked dishes including crackers, biscuits, muffins, pancakes, waffles, noodles, spaghetti, macaroni, and pizza all contain flour milled from wheat as a primary ingredient.

Wheat's preferred role as a food is associated with its protein, which is unique among cereals. The ability of wheat to be prepared as leavened bread is due to the ability of the gluten protein fraction to trap and retain C02 generated during dough fermentation. Except for rye (*Secale cereale* L.) and triticale (X. Triticosecale) to a lesser extent, no other cereal possesses these unique protein properties. Wheat is tasty, nutritious, and easy to process. Its products are bland and appeal to people all over the world.

Triticale is a wheat-and-rye hybrid that was architected to have all of the chromosomes of both of its parents. Its history is extremely brief in comparison to wheat and rye. Production should increase in marginal growing areas where the crop has an advantage over wheat. With only minor modifications, triticale can be processed using the same methods and machinery as wheat and rye. Triticale has had some success as a substitute for traditional wheat products. Despite mixed feeding trial results, triticale's slightly higher protein content and quality (more lysine) inspire hope for its potential as a feed grain. The fact that rye was a close relative of wheat and was very winter-hardy led me to believe that a cross between these two cereals could result in a variety with the hardiness of rye combined with the milling qualities and other desirable characteristics of wheat.

The two main families of triticale are hexaploid triticales, which are amphiploid hybrids of tetraploid wheat and rye, and octoploid triticales, which are amphiploid hybrids of hexaploid wheats. Tetraploid forms have only recently been discovered **(Krolow, 1973).** In 1875, Wilson published the first account of wheat-rye hybrids. The hybrids were completely infertile and unable to reproduce. Four natural wheat-rye hybrids are found in 1914. Three of these were discovered growing in wheat plots on the Arlington Experiment Farm of the United States Department of Agriculture near Washington, and the fourth was sent to Tennessee for identification by **Leighty C.E.**

A number of researchers have demonstrated that hybridising wheat with rye poses no special technical challenges. Beginning in the 1980s, Carman in America, Rimpau and Tschermak in Germany, Jesenko in Austria, and others were successful in artificially producing wheat-rye hybrids. There are also numerous indications of the presence of natural wheat-rye F 1 hybrids in wheat sowings **(LeighV, 1920; Meister, 1921).**

A number of researchers have described plant hybrids that contain the diploid chromosome complement of the parents in recent years. They occur infrequently and are usually produced in combinations that are highly infertile or self-sterile in the F1 generation. Some researchers have labelled such hybrids as "amphidiploids" to emphasize the presence of both parental chromosome sets in one plant in the diploid condition. The majority of known amphidiploids are the result of interspecific and intergeneric artificial hybrids. They are of particular interest to geneticists and cytologists due to the insights they provide into species formation methods, as well as their potential for plant improvement.

1. The Development of Hexaploid Triticale-

Two significant developments occurred in the late 1930s that had a significant impact on triticale research. The first breakthrough was the discovery that colchicine could be used to induce chromosome doubling, allowing for the routine production of new amphiploids **(Kostoff, 1938).** Second, during the same time period, advances in embryo culture allowed hybrids to be produced from normally incompatible parental combinations. These advancements paved the way for the production of hexaploid triticales from tetraploid wheat and rye hybrids. **Derzhavin (1938)** reported the first hexaploid tritical from the cross durum wheat x *Secale montanum.*

O'Mara (1948) developed a hexaploid triticale from a durum wheat x cultivated rye, S. cereale, which would play an important role in the development of triticale in North America and Europe. Several new hexaploid triticales were quickly developed by combining various tetraploid wheats and diploid ryes **(Nakajima, 1952, 1958, 1963; Sanchez-Monge et al., 1956, 1959; Pissarev, 1963; Kiss, 1966; Larter, 1968; Jenkins, 1969).**

According to **Muntzing (1972)**, the first hexaploids produced had such poor seed development that researchers were discouraged from working on a form that appeared to have so little economic potential. Those created by O'Mara and Sgnchez-Monge, on the other hand, were more promising.

P1 (♀) **AABB** **Tetraploid Wheat** × P2 (♂) **RR** **Diploid Rye**

Embryo Culture

F1

A B R

Colchicine treatment to

Double chromosome number

AA BB RR

Fig. 1. Primary Hexaploid Triticale

2. The Development of Octaploid Triticale-

Wilson provided the first account of wheat-and-rye hybrids in 1875. The hybrids were completely infertile and incapable of procreation. German researcher Rimpau succeeded in developing a fruitful variety of bread wheat and rye in 1891. It wasn't until 1935 that this strain's amphiploid status with 2n = 56 chromosomes was established **(Lindschau and Oehler, 1935; Muntzing, 1936).**

Muntzing (1973) claims that Meister saw an unusual outcrossing phenomena in 1918 at the Saratov Experiment Station in Russia. In wheat plots that had been close to rye plots the year before, thousands of natural wheat-rye hybrids appeared. For multiple generations, he created plants from these hybrids, eventually producing true-breeding, more or less fertile derivatives. Meister called the newly discovered species *Triticum seculotricumsurutoviense* Meister and provided a botanical description of it in 1930.

Cytological proof that the novel forms created by Meister from the bread Wheat x Rye crosses amphiploids with 2n = 56 chromosomes was established by **Lewistsky and Benetzkaja** in 1931. Additionally, univalent and other meiotic abnormalities were detected. They assumed that the chromosomes in the parental genomes were incompatible. They hypothesised that amphiploids developed as a result of an apogamous development of F, with ovules having a somatic chromosome number that was doubled during the first division of the egg cell since disrupted pairing could not be caused by a lack of chromosome homology

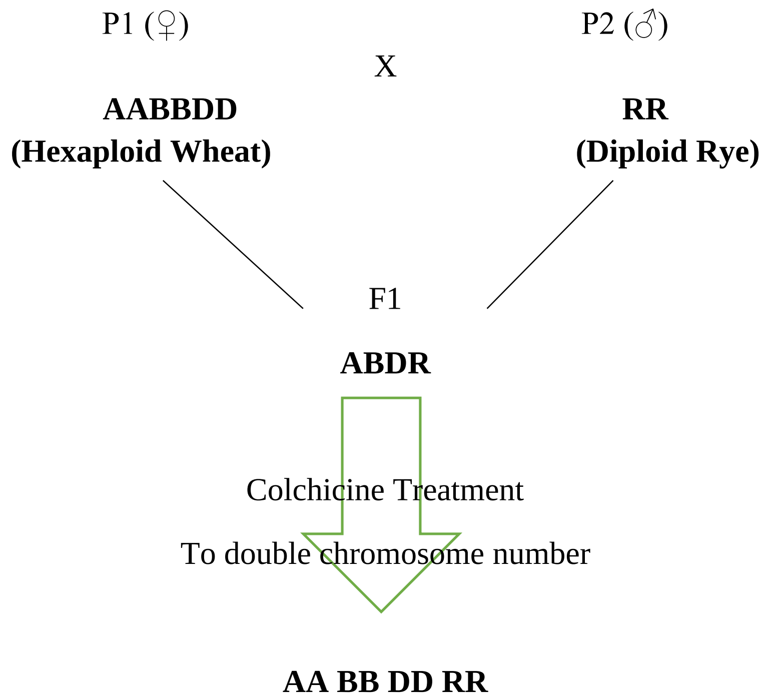

Fig. 2. Primary Octoploid Triticale

❖ Merits and Demerits of Octoploid Triticales

The octoploid triticales are hardy in the winter and flower and mature early. The protein content is higher, and the baking properties are excellent. One disadvantage is partial sterility, which is offset in part by large kernels. Octoploid triticales used to sprout at harvest time when it rained. Breeding work, on the other hand, has the potential to overcome the negative characteristics. Recombinant octoploid strains were found to have a low frequency of aneuploidy and sterility, with euploids having higher fertility than aneuploids **(Weimarck, 1973).** In China, octoploid triticales have been found to be superior at higher altitudes and are cultivated in the Yunnan Kweichow plateau of southwestern China as well as Ningsiahui country in northern China **(Muntzing, 1979).**

❖ Problems, Progress and Research needed-

The first goal of creating wheat-rye hybrids was to introduce some of the advantageous traits of rye into wheat. Because of this, modern triticales, both octoploid and hexaploid, have a number of advantageous traits: (1) they have winter hardiness derived from rye and were thus found to survive in harsh winters, when wheat cultivars used as standards were destroyed or damaged; (2)

they can grow on light soils (medium light to pure sand); (3) like rye, particularly octoploid winter triticales have early flowering, seed maturity, and harvest (4) In comparison to hexaploid wheat, octoploid triticales have larger kernels (average 1000 kernel weight is 50 g in octoploid triticale and 40 g in wheat) and higher protein and lysine content (protein content 18.41% in octoploid triticales and 13.51% in wheat, according to **Muntzing, 1979**).

In China, India, and Mexico, both octoploid and hexaploid triticales outperformed wheat at altitudes of 2000 m and above. Recently, hexaploid triticales have demonstrated the ability to compete with or outperform hexaploid wheat (cultivar Welsh in Canada and Coorong in Australia) and to acquire resistance more easily than wheat **(Wabwoto, 1974; Srivastava, 1974).** As a result of the work done in various countries, remarkable progress in the improvement of hexaploid triticales is known to have been made. However, the work done in Sweden by Muntzing and his colleagues with patience and perseverance resulted in significant improvements in octoploid triticales.

Despite the desirable characteristics described above, both in octoploid and hexaploid triticales, there are some serious issues that have received attention from triticale researchers in recent years: (1) Meiotic instability, aneuploidy, and partial sterility occur in both octoploid and hexaploid triticales, resulting in ears that are not well filled with kernels (as in wheat and rye), though in octoploid triticales, this disadvantage is partially offset by large kernel size. (2) Both octoploid and hexaploid triticales have shrivelled kernels, resulting in lower test weight values than wheat. (3) If the weather is rainy, octoploid triticale and, to a lesser extent, hexaploid triticale kernels sprout before harvest. This is associated with a high amount of a-amylase **(Muntzing, 1979);** (4) there are issues regarding diseases and nutritional aspects; and (5) there is also the issue of lodging in octoploid triticales, which reduces yield. This section will discuss these problems, the progress made, and the possibility of overcoming these problems in the future.

Triticale is destined to establish itself as a significant new element of the range of food and feed grains available globally. Its high yield potential, good biological protein quality, and ability to adapt to settings where wheat is not fit have all given reason for confidence over its future production **(Hulse, 1974).** But before this first artificial cereal grain can reach its full potential, a number of changes must be made. All research institutions dealing with triticales must adhere to the research goals for triticales improvement outlined by **Zillinsky and Borlaug (1971b)** for the CIMMYT programme. The following is a summary of them:

Attacking Elements That Directly Affect Low Grain Yield:

1. An attempt to correct sterility and develop triticales equal in fertility to the best bread and durum wheat's.
2. An attempt to overcome grain endosperm shriveling and improve grain plumpness and test weight.
3. An attempt to introduce early maturity genes.
4. An attempt to introduce dwarfing genes, since triticales are tall growing and susceptible to lodging when grown under heavy fertilization and irrigation.

The Attack on Factors Affecting Yield Stability:

5. An attempt to introduce genes for photoperiod insensitivity, thereby permitting flexibility in dates of sowing.
6. An attempt to introduce genes to widen the zone of adaptation.
7. An attempt to introduce genes to broaden the spectrum of disease resistance.

Except in certain environments, such as high elevations, areas with cool early growth temperatures, and sandy or low fertility soils, triticale does not yet have a competitive advantage over wheat or other cereal grains. There is still a lot of breeding to be done. Grain shriveling, pre-harvest germination, the tendency to produce few tillers under stress conditions, a limited range of adaptation, and ergot susceptibility are the most serious agronomic issues. Significant research is still required to improve its physical properties for commercial food product production.

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