<u>Development of Triticale</u>

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Wheat (*Triticum aestivum* L.) produces more grains per year than any other cereal crop, rivaled only by rice (*Oryza sativa* L.). Wheat is used primarily as a food and provides humans with more nutrients than any other food source. It has been a staple throughout recorded history. It has been proven that wheat was cultivated as early as 8000 to 10000 BC. It is grown as a food crop. The first types of wheat were probably un-threshed wheat. The role of wheat as animal food has always been less than its role as human food. Direct use of wheat as animal feed is usually limited to surplus periods in industrialized countries. However, as a by-product of modern processing, up to 28% of wheat grains, mainly wheat and short willow, find their way into mixed livestock. **(Inglett, 1974).**

Wheat is the most suitable for nutrition. Wheat is used to produce a wide range of products, with sourdough bread being the main product in developed countries, while whole wheat bread is the most popular in developing countries. Pastry products such as rolls, cakes, donuts, biscuits, cakes and other popular foods including biscuits, cookies, briquettes, pancakes, waffles, pasta, spaghetti, pasta and pizza all contain wheat flour as a main ingredient.

The superior dietary role of wheat is due to its protein, which is unique among grains. The ability to prepare wheat as a yeast bread depends on the ability of the gluten protein fraction to capture and retain CO_2 produced during the fermentation of the dough. Apart from rye (*Secale cereale* L.) and triticale (X. *Triticosecale*) to a lesser extent, no other grain has these unique protein properties. Wheat is tasty, nutritious and easy to work with. Its products are boring and appeal to people all over the world.

Triticale is a hybrid of wheat and rye, designed to contain all the chromosomes of both its parents. Its history is very short compared to wheat and rye. It is necessary to increase the production in the neighboring lands where the crop is superior to wheat. Triticale can be processed with only minor modifications using the same methods and techniques as wheat and rye. Triticale has achieved success as a substitute for traditional wheat products. Despite the results of mixed feeding trials, the slightly higher protein content and quality of triticale (more lysine) raises hopes for its potential as a forage grain. The fact that rye was a close relative of wheat and very hardy led me to believe that the result of a cross between the two grains would be a variety that would have the hardiness of rye combined with the sandblasting qualities and other desirable characteristics of wheat.

The two main families of triticales are the hexaploid triticales, which are amphiploid hybrids of quadruped wheat and rye, and the octoploid triticales, which are amphiploid hybrids of hexaploid wheat. Tetraploid forms were discovered only recently **(Krolov, 1973**). In 1875, Wilson published the first report of wheat and rye hybrids. The hybrids were completely sterile and could not reproduce. Four natural hybrids of wheat and rye were found in 1914. Three of them were grown in wheat plots at the United States Department of Agriculture's Arlington Experimental Farm near Washington, D.C., and the fourth by **Leighty C.E**. sent to Tennessee for identification.

Some researchers have shown that crossbreeding wheat with barley does not have specific technical problems. At the beginning of the 80s, Karman in America, Rimpau Cermak in Germany, Jesenko in Austria and others succeeded in artificially producing a hybrid of wheat and rye. There are also many indications of the appearance of natural hybrids of wheat and rye F 1 in wheat cultivation. **(LeighV, 1920; Meister, 1921).**

A number of researchers in recent years have described plant hybrids that contain a diploid set of parental chromosomes. They occur very rarely and are usually produced in mixtures that are highly sterile or self-inoculating in the F1 generation. Some researchers have called such hybrids "amphidiploids" to emphasize the presence of both sets of parental chromosomes in the diploid plant. Most of the known amphidiploids are the result of artificial interspecific and intergenerational hybrids. They are of particular interest to geneticists and cytologists because they provide information on speciation methods as well as their potential for plant improvement.

1. The Development of Hexaploid Triticale-

In the late 1930s, two important developments occurred that had a significant impact on triticale research. The first breakthrough was the discovery that colchicine could be used to stimulate chromosome duplication, allowing the regular production of new amphiploids **(Kostoff, 1938).** Second, during the same period, advances in embryo culture made it possible to produce hybrids from normally incompatible combinations of parents. These developments paved the way for the production of hexaploid triticale from triticale and rye hybrids. **Derzhavin (1938)** reported the first hexaploid wheat from a cross of durum wheat x Secale montanum.

O'Mara (1948) developed the hexaploid triticale of durum wheat x cultivated rye, S. cereale, which played an important role in the development of triticale in North America and Europe. Several new hexaploid wheats were quickly developed by crossing different 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.

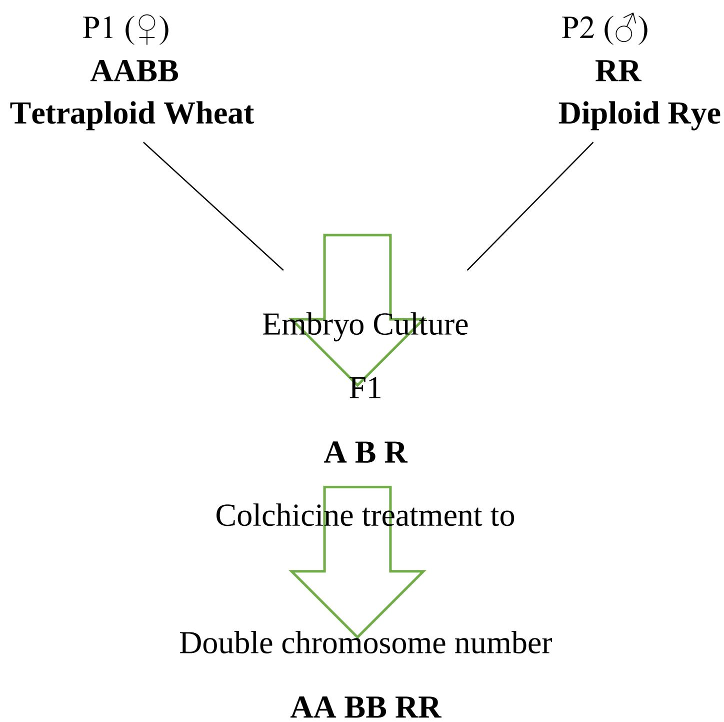

Fig. 1. Primary Hexaploid Triticale

2. The Development of Octaploid Triticale-

Wilson presented the first report of wheat and rye hybrids in 1875. The hybrids were completely sterile and unable to reproduce. In 1891, the German researcher Rimpa managed to create fertile varieties of bread wheat and rye. Only in 1935, the amphiploid status of this species with 2n = 56 chromosomes was established. **(Lindschau and Oehler, 1935; Muntzing, 1936).**

Muntzing (1973) claims that in 1918 at the Saratov Experimental Station in Russia, Meister observed an unusual phenomenon. Thousands of natural hybrids of wheat and rye were found in wheat fields, which were close to rye plants last year. Over the course of several generations, he created plants from these hybrids and eventually produced true, more or less fertile offspring. Meister named the newly discovered species *Triticum seculotricumsurutoviense* Meister and gave its botanical description in 1930.

The cytological proof that the new forms created by Meister from bread wheat x rye to amphiploids with 2n = 56 chromosomes was presented in **1931** by **Lewistsky and Benetzkaja**. In addition, univalent and other meiotic anomalies were discovered. They hypothesized that the chromosomes of the parents' genomes were incompatible. They hypothesized that amphiploids arise as a result of apogamous F evolution in which oocytes have a somatic chromosome number that doubles during the first division of the oocyte because defective pairing cannot occur due to lack of chromosome homology.

P1 (♀) X P2 (♂)

AABBDD (Hexaploid Wheat) **RR** (Diploid Rye)

F1

ABDR

Colchicine Treatment

To double chromosome number

AA BB DD RR

Fig. 2. Primary Octoploid Triticale

Merits and Demerits of Octoploid Triticales

Octoploid triticales are hardy, flower and ripen early. The protein content is higher and the baking properties are excellent. The disadvantage is infertility, which is partially compensated by large kernels. Octoploid triticales germinate early at harvest time when it rains. Breeding has the potential to eliminate negative traits. Recombinant octaploid strains have been found to have a low frequency of aneuploidy and sterility, and euploids have higher fecundity than aneuploids **(Weymark, 1973).** In China, octoploid triticales are dominant at higher altitudes and are cultivated in the Yunnan Weihou Plateau of southwestern China and Ningxiahui Country in northern China **(Muntsing, 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 18.1% in octoploid triticales and 13.51% in wheat, according to **Muntzing, 1979).**

In China, India and Mexico, octoploid and hexaploid triticale dominate wheat at altitudes of 2000 m and above. Recently, hexaploid triticales have been shown to be able to compete with hexaploid wheat (Welsh in Canada and Coorong in Australia) and easily acquire resistance to wheat **(Wabwoto, 1974; Srivastava, 1974).** As a result of the work done in different countries, it is known that significant successes have been achieved in the improvement of hexaploid triticales. However, the patient and determined work done in Sweden by Müntsing and his colleagues has 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 shriveled 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 an 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 an important new element in the palette of food and food grains around the world. Its high yield potential, good quality of biological protein and ability to adapt to environments where wheat is not suitable are reasons to believe in its future production **(Hulse, 1974).** But before this first artificial grain can reach its full potential, some changes must be made. All research organizations dealing with triticales should adhere to the research objectives for triticale improvement outlined by **Zillinsky and Borlaug (1971)** for the CIMMYT program. Below is a brief overview 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 highlands, areas with early growing temperatures, and sandy or fertile soils, triticale still has no competitive advantage over wheat or other cereals. There is still a lot of growing to do. Yield reduction, pre-harvest sprouting, and the tendency of shoots to decrease under stress conditions, the limited range of adaptation and resistance of ergot are the most important agro technical problems. Significant research is needed to improve its physical properties for food production.

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