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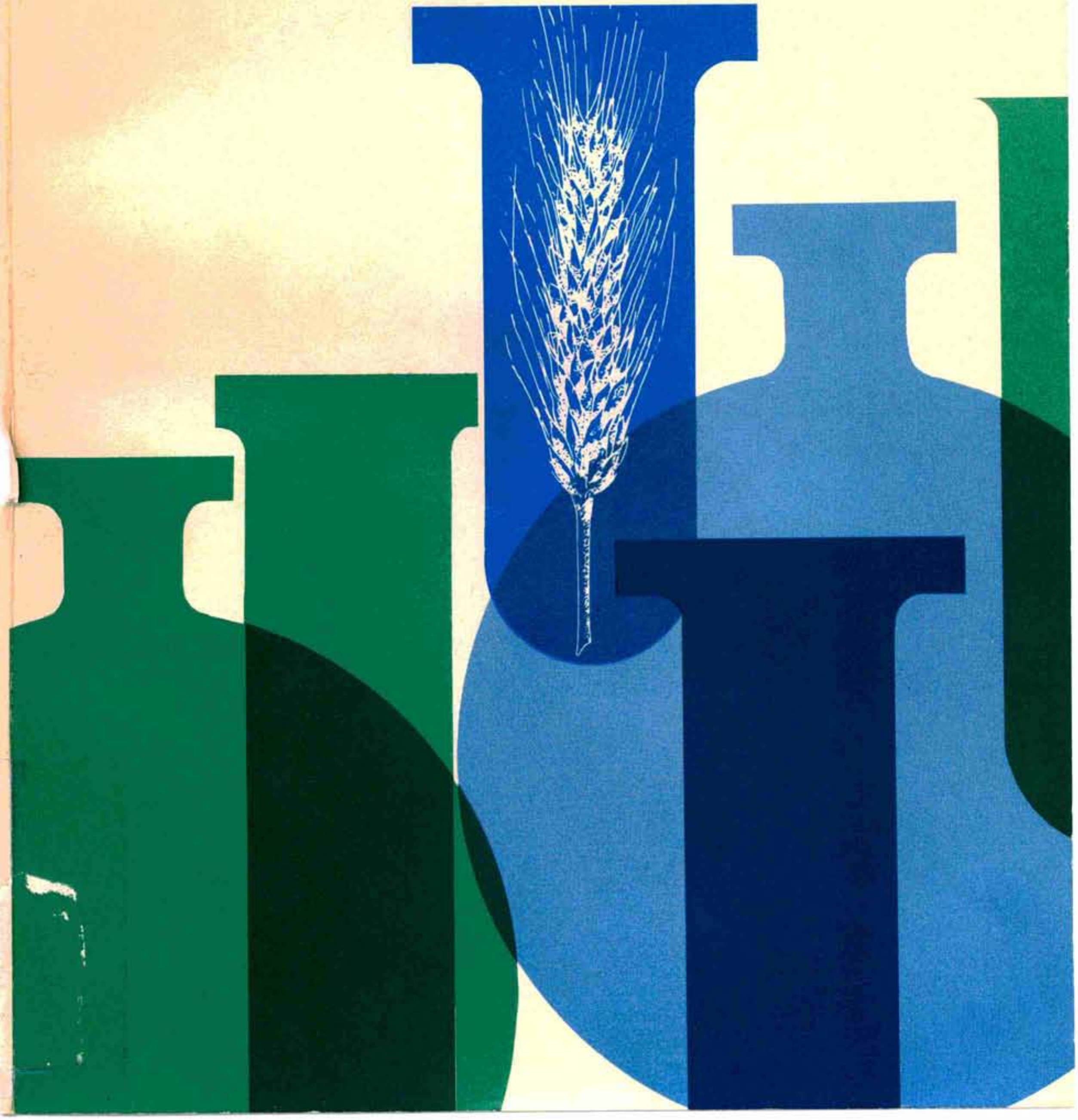
Editors: Reginald MacIntyre/Marilyn Campbell



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Improving Seed Formation in Triticales

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Abstract Inferior seed development resulting in shrivelling, poor germination, and low test weight is a major problem in triticales. The first signs of abnormal development appear during the latter stages of grain filling as flattened areas or depressions on the surface of the seed. As the seed matures, wrinkles appear on the seed coat, the crease deepens, and the endosperm texture becomes chalky rather than vitreous.

It appears that: (1) seed development in triticale is more sensitive to environmental influences than the parental species; (2) better seed development usually occurs among the most fertile strains; (3) the more shrivelled seeds are usually higher in protein content.

Some of the approaches used to overcome endosperm shrivelling are density gradient solutions, visual screening for plumper grain, mutagenic agents, selection for higher fertility, air column separation, and the gravity table. Because of the negative association between dwarfing and plump seed, visual screening tended to eliminate all the dwarf selections. The best results have been obtained from visual selection for plumpness in the most fertile populations. The gravity table will be useful in eliminating the very poor seed types in early generation material.

Résumé Le mauvais développement du grain, qui se traduit par son ratatinage, une mauvaise germination et un poids spécifique faible constitue une difficulté majeure en ce qui a trait aux triticales. Les premiers signes d'un développement anormal apparaissent au cours des derniers stades du remplissage du grain, sous forme de zones aplaties ou de dépressions sur la surface du grain. Au fur et à mesure que le grain mûrit, son tégument se ride, son pli s'approfondit et la texture de l'endosperme devient plus farineuse que vitreuse.

Il semble que: (1) chez le triticale, le développement du grain soit plus sensible aux influences du milieu que chez les espèces parentes; (2) c'est chez les souches les plus fertiles que le développement du grain est habituellement le meilleur; (3) les grains les plus ratatinés sont habituellement ceux dont la teneur en protéine est la plus élevée.

Quelques uns des moyens employés pour parer à ce problème des grains ratatinés sont: les solutions de sédimentation en gradient, le tri visuel des grains les plus pleins, la mutagénèse induite, la sélection en vue d'une fertilité plus élevée, la séparation pneumatique en colonne et le triage gravimétrique. Etant donné la relation négative entre le nanisme et le caractère grain plein, le tri visuel a été orienté vers l'élimination de toutes les variétés naines. C'est avec la sélection visuelle parmi les populations les plus fertiles que l'on a obtenu les meilleurs résultats sur le plan rondeur des grains. Le triage gravimétrique s'est révélé très utile pour éliminer les semences les moins bonnes dans les produits des premières générations.

A UNIVERSAL problem facing scientists working on triticale improvement is inferior seed formation. Seed development after fertilization superficially appears to progress normally during the early stages. As the spikes approach maturity, conspicuous abnormalities appear and become progressively worse as the seeds lose moisture. Usually, the first obvious signs of abnormal development appear as flattened areas or depressions on the endosperm, and the formation of a deep or evacuated crease. As the seed dries, wrinkles appear in the seed coat, lustre disappears, the sides become flattened, and the endosperm texture becomes floury or chalky rather than the hard, vitreous material found in the bread and durum wheats. The seed density is much lower. Dr L. Klepper (unpublished data 1970–71, CIMMYT) points out that the greatest difference in seed development between triticales and the parental species is the proportion of water present in the developing seed beginning shortly after fertilization and continuing until after the seed is physiologically mature.

The most pronounced abnormality in seed development occurs in the primary amphiploids. The octoploids generally have better seeds than the hexaploids. It is even worse in the polyhaploid hybrids to such an extent that embryo culturing is necessary to obtain the hybrid between *Triticum durum* × rye. There is a tendency toward improvement in seed development in the succeeding generations following the A_1 generation of the primary triticales but stops before satisfactory seed development is reached. Further improvement is obtained from secondary triticales, that is, from crosses among primary hexaploid, among primary octoploids, or among crosses between hexaploid and octoploids. The seed development among the early generations of these crosses, particularly from the F_1, is frequently more abnormal than among the parental forms. Improvement again occurs in the first few succeeding generations.

Observations on seed development show: (1) that seed development in triticales is more sensitive to environmental influence than the parental species; (2) that the better seed development occurs among the more fertile types but not necessarily among the most productive ones; and (3) that the more severely shrivelled types have higher protein content, and screening for better seed type and higher yield tends to favour lower protein content.

Dr V. D. Burrows (personal communication) from the Ottawa Research Station, Agriculture Canada, has done some preliminary investigations on seed formation. He found that seed coat shrivelling tends to mask endosperm development. There are forms that have a rather well-developed endosperm but have a wrinkled seed coat, whereas some types with poor endosperm development produce a flattened seed with less shrivelling of the seed coat. However, in general, a high degree of shrivelling indicates poor endosperm development. Burrows has developed a technique of removing the seed coat without destroying germination.

Several approaches have been attempted at CIMMYT to improve seed type:

The use of density gradient liquids for screening heavier seeds — This technique has not been satisfactory. Techniques and density gradient liquids available were too time-consuming and reduced germination.

Early attempts at *visual selection* for plump kernels tended very strongly to eliminate all the selections having dwarfing genes of Norin 10 origin.

Use of mutagenic agents — Dr Ake Gustaffson of Lund, Sweden, treated two strains of triticales from the CIMMYT program with both radiation and chemical mutagens. This material is now in its fifth generation following treatment. Improvement in seed type has not been encouraging, although mutations for characteristics other than seed type, mostly detrimental, were noticeable particularly in the second and third generations after treatment.

Selection for both fertility and seed type on a visual basis among secondary hexaploids derived from hexaploid × octoploid triticales and hexaploid triticales × bread wheat then backcrossed to hexaploid triticales — Visual selection in this material has been the most promising. At the end of the 1972–73 cycle at CIANO, about 15–20 selections had fairly plump grain and test weights of 74–76.5 kg/hl. This is still 8–10 kg/hl below the best bread wheat strains such as Inia.

Gravity table — This is equipment designed by Kipp Kelly, Winnipeg, to separate grains on the basis of density and size. The heavier, larger seeds move upwards on an inclined table, and the lighter, smaller seeds remain on the lower side. The machine requires at least 1 kilo of seed since the table must be covered to operate effectively. This system cannot be used to screen seed from single plants but can be used for bulked early generations. We expect that this type of seed-sorting equipment will be very useful with the bulked material from F_1 and F_2 generations. Material from more advanced generations will be screened on the basis of seed appearance from individual selections until a more effective technique is developed. Although this type of screening will discriminate against the dwarfs, we now have numerous populations having different combinations of dwarfing genes and it is unlikely we will lose complete populations.