GENETICA POLONICA
Vol. 25 1984 No. 4

GENETIC ANALYSIS OF RYE (*SECALE CEREALE* L.) II. LEAF PEROXIDASE ISOENZYMES IN TRISOMIC AND TELOTRISOMICS OF CHROMOSOME OF 1*R*[1]

A. LINDNER, G. MELZ, H. W. MÜLLER, R. BUSCHBECK[2]

Pedagogical High School "Liselotte Hermann", Güstrow; Plant Breeding Institute Gülzow-Güstrow, Academy of Agricultural Sciences of the GDR

Summary. Leaf peroxidase activity was analysed in trisomics and telotrisomics of the rye variety "Esto". Trisomic 1*R* showed a typical alteration in peroxidase pattern in comparison with the variety "Esto". The same difference was observed in telotrisomic 1*RS*; trisomic 1*RL* was comparable with the standard. This means, that at least one gene for peroxidase activity (PER 1) is located on the chromosome arm 1*RS*.

Only few genetic analyses were carried out in rye in comparison with other cereals. They concerned the inheritance of characters and their localization on specific chromosomes (Schlegel, Mettin 1982). However a successful use of modern breeding methods demands the instruction of important characters. At the same time it is necessary to find markers which make the breeding-process more efficient. The trisomic analysis is one of the methods to localize genes on chromosomes. Using trisomics and their specific segregation after crossing in F_2—like progenies it was possible to find several markers on chromosomes (Sturm, Engel 1980, Sturm et al. 1981, Sturm, Müller 1982, Melz et al. in press). Until now biochemical markers of rye were localized only by analysing wheat-rye hybrids (Irani, Bhatia 1972, Tang, Hart 1975, Höhler et al. 1979, Rao, Rao 1980, Artyomova 1982, Hsam et al. 1982). The aim of our work was to find a possibility to localize biochemical markers of rye by trisomics as well.

MATERIAL AND METHODS

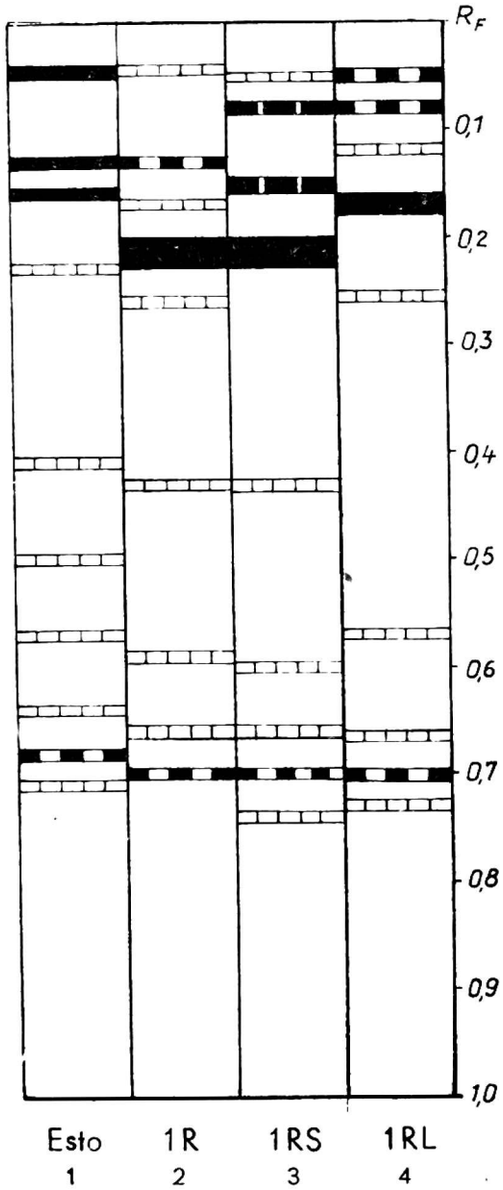
The analysis was done by the help of a set of trisomics derived from the rye variety "Esto" (Sturm 1978). The trisomics were named following the nomenclature of the 1st Workshop on Rye Cytogenetics in Wageningen (1982), which means that the

[1] Received for publication: May, 1984.

[2] First Author: Prof. dr. Second Author: Dr. Third and fourth Authors: Prof. dr. Present address: First Author: Pädagogische Hochschule "Liselotte Hermann", Goldberger Strasse 12, 2600 Güstrow, DDR. Second and third Authors: Institute für Pflanzenzüchtung der Akademie der Landwirtschaftswissenschaften der DDR, 2601 Gülzow-Güstrow, DDR.

chromosomes were designated as $1R$ to $7R$. In addition to this, a set of telotrisomics (Sturm, Melz 1982) was used for analysis. Trisomic and telotrisomic plants were cloned and the youngest leaves of the clones were taken for preparation with five repetitions. The clones grew under the same environmental conditions. The leaves were extracted in 0.1 m Tris-HCl-buffer pH 0.8 (Staples, Stahmann 1964) and than a disk-electrophoresis was carried out in basic standard system No. 1 (Maurer 1968) with cylindric gels (5×70 mm). Multiple forms of peroxidases (EC1. 11. 1. 7.) were detected by staining (Rychter, Lewark 1971). Zymograms of trisomics and telotrisomics were compared with the zymogram of the standard variety "Esto".

RESULTS AND DISCUSSION



The standard variety "Esto" showed a typical zymogram (Fig. 1), while trisomic $1R$ ($1R$=SAT chromosome) was different. The band at R_F=0.23 is of considerable intensity, while it is weak in the standard and the other trisomics. This result inclined us to test the two possible telotrisomics of chromosome $1R$ ($1RS$ and $1RL$) as well. The zymogram of telotrisomic $1RL$ was identical with that of the standard, while telotrisomic $1RS$ showed the same pattern as trisomic $1R$ (Fig. 1). This means, that at least one gene for peroxidase activity is located on chromosome arm $1RS$. The gene should be designated as PER 1.

These results prove, that it is possible to localize biochemical markers using trisomics and telotrisomics of rye. Moreover, findings of Höhler et al. (1979) were confirmed, but there is no qualitative effect in case of trisomics as in wheat-rye hybrids. As special crosses were not made before preparation and all

Fig. 1. Leaf peroxidase isoenzymes
1 – "Esto", *2* – trisomic $1R$, *3* – telotrisomic $1RS$, *4* – telotrisomic $1RL$

trisomics and telotrisomics descend from "Esto", a strong band (R_F=0.23) is not likely to be due to specific allele combinations. On the other hand, it must be concluded, that there is a dosage effect in the case under study. This agrees well with the findings for *Petunia* (van den Berg, Wijsman 1982), barley (Nielsen, Frydenberg 1971), maize (Nielsen, Scandalios 1974), tomato (Fobes 1980) and *Lolium* (Lewis et al. 1980). The reason for the dosage effect could be the additional gene copy in the trisomic genotype AAA resulting in more gene products than with the

genes in the disomic genotype AA. This results finally in a higher intensity of a usually weak band at R_F=0.23.

It must be expected that there are further genes controlling leaf peroxidases, because Garcia et al. (1982) observed 13 endosperm and embryo peroxidase genes in rye. Our research work in this field has not been completed yet, but there is some reason to expect further peroxidase genes on rye chromosomes $2R$, $3R$ and $7R$.

If it is possible to localize more isoenzymes on rye chromosomes, the identification of chromosomes will be more reliable. This possibility is especially important for identification of rye chromosomes and their part in substituted or translocated wheat, for recognition of structural changes in rye chromosomes after crossing with other species and for completion of a standard nomenclature of rye chromosomes.

REFERENCES

1. Artyomova N. V. (1982). Chromosomal control of alcohol dehydrogenase-, esterase- and beta-amylase-isoenzymes in various rye varieties. Genetika, Moskwa, 18, 661 - 668.
2. Berg B. M. van den, Wijsman H. J. W. (1982). Genetics of the peroxidase isoenzymes in *Petunia*. Part 2: Location and developmental expression of the structural gene *prxB*. Theor. Appl. Genet. 61, 297 - 303.
3. Fobes I. F. (1980). Trisomic analysis of isozymic loci in tomato species: segregation and dosage effects. Biochem. Genet. 18, 401 - 421.
4. Garcia P., Perez de la Vega M., Benito B. (1982). The inheritance of rye seed peroxidases. Theor. Appl. Genet. 61, 341 - 353.
5. Hart G. E. (1978). Chromosomal arm location of Adh-R_1 and acid phosphatase structural gene in Imperial rye. Cereal Res. Com. 6, 123 - 133.
6. Höhler B., Schlegel R., Blüthner W.-D. (1979). Das Muster von Peroxidaseisoenzymen in 1R/1B/-Weizen-Roggen-Substitutions-bzw. 1B-1R-Translokationslinien. Biochem. u. Physiol. Pfl. 174, 838 - 843.
7. Hsam S. L. K., Zeller F. J., Huber W. (1982). Genetic control of 6-phosphogluconate dehydrogenase (6-PGD) isozymes in cultivated wheat and rye. Theor. Appl. Genet. 62, 317 - - 321.
8. Irani B. N., Bhatia C. R. (1972). Chromosomal location of alcoholdehydrogenase gene (s) in rye, using wheat-rye addition lines. Genetica 43, 195 - 200.
9. Lewis E. J., Humphreys M. W., Caton M. P. (1980) Chromosome location of two isozymic loci in *Lolium perenne* using primary trisomics. Theor. Appl. Genet. 57, 237 - 239.
10. Maurer H. R. (1968) Disc electrophoresis and related technique of polyacrylamid gel electrophoresis. W. de Gruyter, Berlin (1968).
11. Melz G., Neumann H., Müller H. W., Sturm W. (1984) Genetical analysis of rye (*Secale cereale* L.) 1. Results of gene location on rye chromosomes using primary trisomics. Genet. Polon., in press.
12. Nielsen G., Frydenberg O. (1971) Chromosome localization on the esterase loci Est-1 and Est-2 in barley by means of trisomics. Hereditas 67, 152 - 154.
13. Nielsen G., Scandalios J. G. (1974) Chromosomal location by use of trisomics and new alleles of an endopeptidase in *Zea mays*. Genetics 77, 679 - 686.
14. Rao I. N., Rao P. V. M. (1980) Evidence for duplicate genes coding for 6-phosphogluconate dehydrogenase in rye. Genet. Res. 35, 309 - 312.
15. Rychter A., Lewak S. (1971) Apple embryo peroxidases. Phytochemistry 10, 2609 - 2613.
16. Schlegel R., Mettin D. (1964) The present status of chromosome recognition and gene localization in rye, *Secale cereale* L. Tag.-Ber., Akad. Landwirtsch.-Wiss. DDR 198, 131 -152.

17. Staples R. C., Stahmann M. A. (1964). Changes in protein and several enzymes in susceptible bean leaves after infection by the rust fungus. Pythopath. 54, 760 - 764.
18. Sturm W. (1978). Identifizierung von Trisomen der Sorte „Esto" und Trisomenanalyse des Gens Hl für Kurzstrohigkeit bei *Secale cereale* L. Akad. Landwirtsch.-Wiss. DDR, Berlin, Diss. A, 180 S.
19. Sturm W., Engel E.-H. (1980) Trisomenanalyse des Gens Hl für Kurzstrohigkeit bei *Secale cereale* L. Arch. Züchtungsforsch. 10, 31 - 35.
20. Sturm W., Melz G. (1982) Telotrisome — *Secale cereale* L. Tag.-Ber. Akad. Landwirtsch.-Wiss. DDR 198, 217 - 225.
21. Sturm W., Müller H. W. (1982) Localization of the recessive gene of the Moscow dwarf mutant short-stalk character in *Secale cereale* L. Citol. i Gen., Kiev, 16, 13 - 17.
22. Sturm W., Neumann H., Melz G. (1981) Trisomenanalyse für das Merkmal Anthocyanfärbung bei *Secale cereale* L. Arch. Züchtungsforsch. 11, 49 - 53.
23. Tang K. S., Hart G. E. (1975): Use of isozymes as chromosome markers in wheat-rye addition lines and in *triticale*. Genet. Res. 26, 187 - 201.

ANALIZA GENETYCZNA ŻYTA (*SECALE CEREALE* L.)
II. IZOENZYMY PEROKSYDAZ W LIŚCIACH TRISOMIKÓW I TELOTRISOMIKÓW CHROMOSOMU 1*R*

Streszczenie

Analizowano aktywność peroksydazy w liściach trisomików i telotrisomików chromosomu 1*R* żyta odmiany Esto. Trisomik 1*R* charakteryzuje się typową zmianą w obrazie peroksydazy w porównaniu z odmianą Esto. Taką samą różnicę zaobserwowano u telotrisomika 1 *RS*;trisomik 1*RL* był porównywalny ze standardem. Oznacza to, że przynajmniej jeden gen dla aktywności peroksydazy PER1 znajduje się na ramieniu chromosomu 1*RS*.

ГЕНЕТИЧЕСКИЙ АНАЛИЗ РЖИ (*SECALE CEREALE* L.)
II. ИЗОЭНЗИМЫ ПЕРОКСИДАЗ ЛИСТЬЕВ У ТРИСОМИКОВ И ТЕЛЕТРИСОМИКОВ ХРОМОСОМЫ 1*R*

Резюме

Анализировалась активность пероксидазы листьев у трисомиков и телотрисомиков ржи сорта Esto. Трисомик 1*R* характеризовался типичным изменением в спектре пероксидазы по сравнению с сортом Esto. Такая же самая разница наблюдалась у телотрисомика 1*RS*; трисомик 1*RL* сравнивался со стандартом. Это значит, что по крайней мере один ген для активности пероксидазы ПЕР1 находится на плече хромосомы 1*RS*.