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THE TESTING OF EFFICACY OF CHA GENESIS® FOR PRODUCTION OF HYBRID WHEAT AND HYBRID TRITICALE

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Summary

The objectives of the joint project "Hybrid Wheat and Hybrid Triticale Research in the Czech Republic" conducted by Monsanto Company (USA) and the Agricultural Research Institute Kroměříž, Ltd. were to evaluate the efficacy of the CHA Genesis under climatic and soil conditions of the Czech Republic using potential parent components of wheat and triticale, to assess an effective Genesis dose and produce a necessary amount of experimental hybrid wheat and hybrid triticale seed for yield trials. Evaluating the yield of tested wheat parental components, significant differences were found between individual variants of treatment. If the percentages of sterility and hybrids using the technique of bagging were assessed, significant differences in all doses in relation to the untreated check and significant differences between the dose of 1.6 kg.ha⁻¹ Genesis to both increased doses were calculated. Insignificant differences were found between the dose of 3.6 and 4.9 kg.ha⁻¹ Genesis. If the percentage of hybrids was assessed by electrophoresis of storage proteins, significant differences were also calculated between the dose 3.6 and 4.9 kg.ha⁻¹ Genesis. Based on the obtained results, it is possible to conclude the CHA Genesis dose of 4.9 kg.ha⁻¹ appeared sufficient to induce nearly 100% (99.5% in wheat and 96.7% in triticale) male sterility of female plants under investigated soil and climatic conditions in the Czech Republic.

Key words: chemical hybridising agent Genesis, wheat, triticale, male sterility, hybrid purity, electrophoresis

Introduction

Chemical hybridising agents (CHA) are chemical substances that are used to induce male sterility in female plants. The possible use of CHAs has been investigated in at least 40 species, including all the major cereals of the world and several other crops of great economic importance (Pickett, 1993). CHAs prevent normal production of pollen at keeping female fertility which enables to produce hybrid seed and to overcome a lot of problems associated with exploitation of cytoplasmic male sterility (Nesvadba et al., 1998). Great experience with utilization of CHA and production of hybrid wheat has been obtained in the USA and France. On the basis of Genesis, the first wheat hybrids of the Quantum series in hard and soft red wheats were developed and released to farmers for commercial production in the USA in 1996. In France, six hybrid wheats (Cockpit, Cabestan, Domino, Mercury, Sextant and Twin) have been registered since 1995. In Germany the first hybrid wheat Hybnos 1 from Nordsaat - Saatzucht was registered in a List of Registered Varieties in 1999 (Nesvadba, Vyhnánek, 2001).

This paper presents the results of the yield evaluation, male sterility and hybrid purity of twenty varieties and lines of wheat and five genotypes of triticale produced using Genesis compound.

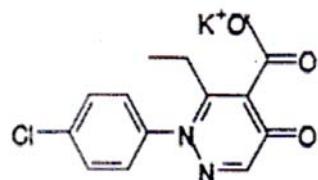
Materials and methods

Genesis is a chemical agent developed by Monsanto (USA) for HybriTech for wheat hybridization. Genesis contains 244 g.l⁻¹ active ingredient clofencet [2-(4-chlorophenyl)-3-ethyl-2,5-dihydro-5-oxopyridazine-4-karboxylate, potassium salt]; C13H10N2O3CIK (Fig. 1).

Clofencet is a systemic product which is translocated in wheat from leaves to flowers. It is in accordance with development of anthers when it sterilizes pollen grains (Fichet and Adams, 1996).

The experiments in both years were established in the fields of the Agricultural Research Institute Kroměříž, Ltd. which is located in the mild dry area of the warmer sugar beet-growing region with mild winter (a long-term annual sum of rainfall is 599 mm and average daily temperature is 8.7 °C). The altitude of experimental fields is 210 to 220 m. The soil is Luvi-haplic Chernozem with pH 6.1- 6.8.

Fig. 1: Structural chemical formula of clofencet



A) The experiment "Evaluation of wheat parents responses to Genesis application" was conducted to test selected varieties and lines of winter wheat and their reaction to three doses of the gametocide Genesis (1.6 - 3.6 - 4.9 kg.ha⁻¹) in combination with a surfactant (MON 8161, 1 % c.v.) and a humectant (MON 8165, 2 % c.v.) in comparison with the untreated check. Water carrier volume (c.v.) was 500 l.ha⁻¹. The details of the experimental layout have been reported in a previous paper (Nesvadba, Vyhnanek, 2001).

B) The experiment "Top cross of triticale" was conducted to produce hybrid triticale seed in five varieties and line in one block with one male component for subsequent yield trials. Hexaploid winter triticale (2n=42) was used for this experiment. The varieties Chrono (POL), Kolor (CZE), Presto (POL), Tornado (POL) and line KM 779 from Agricultural Research Institut Kroměříž, Ltd. were the female components. The German variety Modus was used as male parent. The details of the experimental layout have been described in a paper (Vyhnanek, Bednář, 1999).

Results and discussion

In our experiments we tested the efficacy of the chemical hybridizing agent Genesis for induction of male sterility and subsequent crosses of female and male components on selected varieties and lines of winter wheat. Based on the obtained results, it is possible to conclude that the Genesis dose of 4.9 kg.ha⁻¹ appeared sufficient to induce nearly 100% (99.5%) male sterility of female plants under investigated soil and climatic conditions in the Czech Republic.

Evaluating the yield of tested wheat parental components, significant differences were found between individual variants of treatment. If the percentages of sterility and hybrids using the technique of bagging were assessed, significant differences in all doses in relation to the untreated check and significant differences between the dose of 1.6 kg.ha⁻¹ Genesis to both increased doses were calculated. However, insignificant differences were found between the dose of 3.6 and 4.9 kg.ha⁻¹ Genesis (Tab. 1).

Tab. 1: Analysis of variance - estimation of feasibility of female components after the application of Genesis technique - bagging

Source of variation	Number of degrees of freedom (df)	Variance (MS)		
		yield	% sterility	% hybrid seeds
Year (A)	1	10.55**	1.31	0.41
Dose (B)	3	493.44**	147483.15**	141292.03**
Variety (C)	19	12.44**	25.31**	35.27**
A x B	3	10.13**	6.18	6.73
A x C	19	2.15**	31.77**	60.96**
B x C	57	1.71**	12.10	20.96
Residual	217	0.77	8.80	17.31

Individual wheat genotypes were differentiated by means of prolamin storage proteins and used for the assessment of the percentage of hybrid seed when their codominant inheritance was used. The doses of 1.6 and 3.6 kg.ha⁻¹ displayed the efficacy on the average of two years from 41.3 to 56.3 % depending on genotypic specificity. If the percentage of hybrids was assessed by electrophoresis of storage proteins, significant differences were also calculated between the dose of 4.9 and 3.6 kg.ha⁻¹ Genesis (Tab. 2).

At the heading stage, pollen grains were present in anthers of wheat plants that had been treated with the dose of 4.9 kg.ha⁻¹ Genesis. The anthers were reduced in size and green-yellow in colour in comparison with the untreated check. There was only an exine in the pollen grain. Based on visual evaluation of treated spikes, it can be assumed that pollen grains are formed even after Genesis application, however, they are not shed out of anthers at the flowering stage and are not able to pollinate either.

The prolamine spectra of grain of all the analysed triticale parental genotypes are homogenous, with the exception of variety Tornado and the line KM 779 which are heterogenous in terms of prolamine. These genotypes consist of two sister prolamine lines (identity index (ii) 0.88 (Tornado) and 0.69 (KM 779)).

Tab. 2: Effect of selected female genotypes on examined characters

Genotype	Yield (t.ha ⁻¹) ¹⁾	% sterility ²⁾	% hybrid seeds ²⁾	% hybrid seeds ³⁾
Hana	3.76 a	99.8 a	99.7 a	60.4
Astella	6.21 b	99.5 a	98.8 a	68.9

1) mean of 16 assessments – doses of 0, 1.6, 3.6 and 4.9 kg.ha⁻¹ Genesis

2) mean of 12 assessments - technique of bagging – doses of 1.6, 3.6 and 4.9 kg.ha⁻¹ Genesis

3) mean of 6 assessments – technique of electrophoresis – doses of 1.6, 3.6 and 4.9 kg.ha⁻¹ Genesis

a, b – homogeneous groups, significance at P > 95%

Specific female and male bands of the prolamine spectrum were found in the F1 generation of triticale. Their expression shows that the dose 4.9kg.ha⁻¹ Genesis, mode and date of application was 100% efficient. Only in the hybrid combination Chrono x Modus we found the lower efficacy (83.3%) (Tab. 3).

Tab. 3: Efficiency of the CHA Genesis gametocide in the top-cross of triticale

% cross-pollination

female \ male	MODUS
CHRONO	83.3
KOLOR	100
PRESTO	100
TORNADO	100
KM 779	100

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Electrophoretic analysis were supported by the Experimental Scheme AF MZLU Brno (MSM 432100001).