

THE EFFECT OF CEREAL BREEDING ON AGRICULTURE IN POLAND**Tadeusz Wolski**Poznan Plant Breeders
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Poland**ABSTRACT**

The effects of a new winter rye and winter wheat variety on agriculture in Poland are determined from yield increases in official trials. The increase in rye yields was up to 6% in an improved existing variety and was 2-8% in a new variety. Superior resistance to lodging was also an advantage. The introduction of Grana wheat led to yield increases of 2-15%. The effect of breeding on grain production is discussed in reference to average national yield. Partially replacing rye with triticale is predicted to increase grain yields by 3% and protein content by 2%. Resistance to lodging and disease would also be higher

KEYWORDS

Rye, wheat, triticale, yields, lodging resistance.

INTRODUCTION

Evaluation of the gains made from breeding is of interest to both farmers and breeders — farmers can see the possible returns from new varieties and breeders are able to assess the value of their work.

The improvement in quality and yield as a result of the plant breeder's efforts are sometimes difficult to determine, because of the accompanying environmental effects. The partitioning of the contributions to improved performance due to genotype or due to environment based on trial results, can be difficult and sometimes erroneous. The application of up to date agronomic practices to newly released cultivars and the response of these cultivars to the different treatment, highlight the problem. Cultivars used a long time ago are unable to tolerate or make use of high levels of nitrogen and conversely modern ones do not thrive under primitive growing conditions.

Table 1. Total area (million ha), yield (million t) and mean yield (t/ha) of grain in Poland.

Period	4 cereals			area	Rye		area	Wheat	
	total yield	mean yield	total yield		mean yield	total yield		mean yield	
1946-1955	9	11	1.2	5	6	1.2	1.5	2.0	1.3
1971-1980	7	18	2.6	3	7	2.3	1.9	5.5	2.4

Source: Polish Statistical Yearbooks.

Yield increase attributable to varietal improvement has been assessed by extrapolating yield increases in trials to commercial production (Krzymuski 1982, 1985; Schuster *et al.* 1982). Krzymuski also takes into account the area of new varieties.

The objective of this paper is to present the improvement due to new varieties using Dankowskie Zlote rye and Grana winter wheat.

MATERIAL AND METHODS

Two important cereal crops in Poland have been chosen for this presentation, winter rye and winter wheat. Grain yields from official trials for the period 1966-1985 for rye and 1968-1982 for wheat have been grouped into 5-yearly means. The figures were obtained from those published by the Ministry of Agriculture and COBORU (the Research Centre for Agricultural Crop Cultivars). Yearly means were from 47 to 69 rye trials each year and 57 to 77 wheat trials, from stations throughout the country. As new cultivars become widely grown about 3 years after release, the yields were calculated from 1971 for Dankowskie Zlote rye and 1973 for Grana wheat.

Rye cultivars, being open-pollinated, would be expected to improve over time due to maintenance breeding.

RESULTS AND DISCUSSION

In Poland, changes in area, total production and mean yields have occurred for all cereals, including wheat and rye, since World War II (Table 1). There has been a large decrease in the area sown to rye and an increase in the wheat area. The yield per hectare for cereals has almost doubled during that period.

Table 2. Grain yields of improved rye cultivars in Polish Official Trials.

Period	Old cultivars L + W1	Grain yield t/ha		Yield increase %		D. Seleke over D.Zlote
		Dank. Selek.	Dank. Zlote	Over old cv. D.Sel	D.Z1	
1966-1970	3.32	3.53	3.60	6**	8**	2
1971-1975		3.93	4.09			4*
1976-1980		4.39	4.53			3
1981-1985		4.64	4.96			7*

** , * significance at 0.01 and 0.05 levels respectively.

Rye

The relatively large area sown to rye is due to the prevalence of sandy, acid soils and the severe climatic conditions. Selection within the open-pollinated rye cultivars has resulted in their improved performance as well as in the development of new cultivars. The progress made from selection within existing cultivars was dependent upon their original genetic constitution. An example of this is given in Table 2, Dankowskie Selekcyjne released at the end of the past century was earlier inferior or equal in yield to leading cultivars Ludowe and Wloszanowskie, which at that time occupied 60% of the rye area. As a result of new breeding methods (Wolski, 1985) the yield of Dankowskie Selekcyjne was increased so that by 1966-70 it outyielded Ludowe and Wloszanowskie by 0.21 t/ha (6%).

Dankowskie Zlote rye, released in 1968, had superior lodging resistance and a better yield than Dankowskie Selekcyjne. During the early years in trial the yield advantage was small (2%) but the yield difference increased in the 1981-85 period to 7%, indicating a 5% improvement as a result of the breeding effort. There was a yield increase of over 30% for both cultivars in the twenty-year period 1966-85.

Krzymuski (1982) estimated that an improvement of 1 point in his 9 point lodging resistance scale made it possible to use 30 kg/ha extra nitrogen, which results in 0.25 t/ha additional grain. The superior lodging resistance of Dankowskie Zlote with a 1.8 points higher lodging resistance score would allow up to 54 kg/ha more nitrogen to be applied and give an expected increase of 0.45 t/ha of grain. The yield differential in trials without lodging was 0.77 t/ha. This estimate compared well with that found in practice on the state farm in Central-West Poland where 0.8

t/ha extra yield was obtained from Dankowskie Zlote rye.

These figures apply to the better farms, where the yields are not less than 80% of the yields obtained from trial sites (Krzymuski 1982), that is from 2.9 to 4.0 t/ha during the period 1966-85. Recently, rye yields as high as 6 t/ha have been obtained in Poland. If the percentage yield increase due to breeding estimated from the trial data were to be applied to the average national yield, then the increase would be only 0.15 t/ha.

Schuster *et al.* (1982) showed that rye yields in the German Federal Republic had increased by 0.35 t/ha (31%) in the years 1979-82.

Dankowskie Zlote rye has occupied over 60% of the area sown in this crop for the past 15 years. In recent times this would have been nearer 85% if Danko, a reselection with equal yield but better lodging resistance, were added to the area (Table 3). This represents over 2.5 million hectares.

Wheat

The winter wheat Grana was released in 1970. Wheat cultivars have come and gone much more frequently than rye. It was therefore not possible to compare Grana with older cultivars for any appreciable length of time. Only Mironowskaya 808 could be compared with Grana for a 10 year period (Table 4). This cultivar had about the same yield as those grown at that time of its release. During the first period (1968-72) the yield advantage of Grana was insignificant but in the second (1973-77), the yield advantage of Grana was 15%, mainly due to better agronomic practices.

Grana has better lodging resistance than Mironowskaya 808, over 2 points on a 9 point scale, averaged over 10 years. According to Krzymuski (1982) this

Table 3. Introduction of high yielding rye cultivars in Poland.

Period	Average national yield t/ha	% of growing area				
		Old cv.	Dank. Sel	Dank. Z1.	Danko	Other cv.
1956-1960	1.46	89	11			
1961-1965	1.64	86	14			
1966-1970	1.82	51	27	21		
1971-1976	2.32	2	22	62		14
1976-1980	2.37			68	17	13

Table 4. Yield in Polish Official Trials and growing area of the winter wheat cultivars Micronowskaya 808 and Grana.

Period	Grain yield t/ha		Yield increase %	% of growing area		Average national grain yields t/ha
	Miron. 808	Grana		Miron. 808	Grana	
1968-1972	3.83	3.93	2	9.4	8.1	2.47
1973-1977	4.02	4.63	15**	25.6	35.0	3.05
1978-1982		5.03		4.0	30.7	2.92

** significance at 0.01 level.

should allow an extra 66 kg/ha of nitrogen to be used and theoretically make it possible to obtain yield increases of up to 0.6 t/ha.

Grana was grown over a 10 year period on about 0.5 million hectares each year. Using data from trials to estimate the gain in yield at a national level a figure of 0.45 t/ha is obtained or an annual yield increase for the country of about 0.22 million tonnes.

The effect of agronomic practices, especially nitrogen application, are much more pronounced in wheat than in rye and this makes it even more difficult to estimate the contribution made from breeding to the national yield. The figures (Tables 2 and 4) suggest that the contribution from breeding may be higher for rye than for wheat. Grana is still grown in Poland on about 13% of the wheat area. During the 1980's higher yielding wheat cultivars have been released, namely Liwilla, Emika, Beta, Jawa, Weneda and Lanca.

Triticale

Starting in 1982, the first Polish winter triticales were released and were greeted with enthusiasm by farms. The main objective of releasing triticale was to partially replace rye in order to improve yields and increase the feed value of the grain (Wolski, 1986).

The triticale Grado has been compared with standard wheat and rye cultivars (Table 5). There was a slight yield advantage in favour of triticale over a three year period. Winter damage reduced the yield of triticale in 1982. Triticale does not lodge as readily as rye and has better protein content and better overall disease resistance than both wheat and rye. One of the main advantages of triticale is its tolerance to aluminium toxicity and acid soil

conditions. Farmers have reported up to 50% yield advantage of triticale over other cereals, especially when heavy mildew and rust attacks occur.

New triticale cultivars are now in official trials with a higher yield potential, better winter hardiness and yield increases of 2% are expected.

The government has projected a target of one million hectares of triticale by 1990 with an expected yield advantage of 5% over rye. This would give an additional yield of 0.12 million tonnes of grain with a higher protein content and better feed value than existing cereals.

CONCLUSIONS

Yield increases directly attributable to plant breeding are difficult to determine. However, estimates have been made of the gains in Poland from the breeding effort. For Dankowskie Zlote rye this amounts to 0.375 million tonnes and for Grana wheat 0.220 million tonnes. The introduction of triticale is expected to bring further gains in yield of at least 0.12 million tonnes plus an improvement in grain quality. The introduction of short-strawed, lodging resistant cultivars has also improved agricultural practices.

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Table 5. Comparison of triticale cv. Grado, wheat cv. Grana and rye cv Dankowskie Zlote in Polish Official Trials (according to COBORU 1982-1984).

Cultivar	Grain yield t/ha				Protein content %	Lodg. ¹ resis.	Mild. ¹ resis.	Leaf ¹ rust resis.
	1982	1983	1984	mean				
Grado triticale	4.80	5.91	5.61	5.44	12.0	7.6	8.7	8.9
Grana wheat	4.95	5.62	5.10	5.22	11.4	8.2	7.1	6.5
D. Zlote rye	5.47	5.29	5.11	5.29	9.9	6.8	7.4	5.6

¹ Score on a scale 1-9, where 9 is most resistant.

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SYMPOSIUM DISCUSSION

Dr D.S.C. Wright, Crop Research Division, DSIR

In view of the points you have made about lodging resistance and the application of nitrogen, are you attempting to shorten the straw of your triticales and ryes, and do the farmers use chemical straw shorteners?

Wolski

We are attempting to shorten the straw, but in the case of rye, it's a question more of lodging resistance. We have varieties with rather long straw, which have good lodging resistance compared to other European varieties. There are two additional factors of importance in Poland, farmers are still interested in rather high straw production, and more importantly, longer straw allows the growing of rye without herbicide. With short varieties there is the problem of weeds. Of course yields would be higher if herbicides were used for short-strawed varieties, but rye grain is much cheaper in Poland now, so the farmers are not willing to spend much on herbicide.

In triticale we are looking more to the future, and paying more attention to shortening the stem. Presently released varieties are about 120 cm. We have a number of advanced lines in our breeding programme which are shorter.

Mr L.M.W. Suijs, Geertsema Zaden B.V.

The maintenance breeding of rye seems to have improved your varieties very much. Does this also apply to triticale?

Wolski

Not as much, although we believe triticale is between rye, and wheat, in this respect. With lower partial open pollination, at around 5% and a longer period of segregation which we observe in our area we believe that we should also use trials between sublines. Of course this rye breeding method is not in accordance with the modern concept of quite stable variety that should not change.

Griffin

You indicated that most of the triticale is used for feed grains. In New Zealand some claim has been made about using Lasko for breadmaking. Would you comment on breadmaking quality.

Wolski

We use most of our rye and wheat production for animal feed. The national interest speaks of replacing rye with triticale for feeding. We should still have one to two million hectares of rye in the future, which should be sufficient for our baking industry.

We may test triticale for baking, in the future — its quite a good material for bread making, especially where the population is used to rye bread, as it has a similar taste. The leaf volume is lower, but the taste is excellent.

Dr E.J. Walsh, University College, Dublin

Were the comparisons between wheat, triticale and rye made in an environment that was ideal for wheat, or was it marginal?

Wolski

The trials were in an area where both wheat and rye could be grown but the rye generally yielded higher. However, it was not representative of triticale growing conditions. One thing I omitted to present in this table is that the data are not a direct comparison of triticale with rye and wheat in the same trials, but are from separate trials at the same locations.