TRENDS IN WINTER WHEAT PERFORMANCE IN AN INTERNATIONAL TRIAL

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CHAPTER I

INTRODUCTION

Wheat is the major food crop in many parts of the world. On the basis of both acreage and production, wheat is the world's leading crop. Metcalfe and Elkins (14) indicated that wheat occupies about 65% greater acreage than rice, and production is about 20% greater than rice.

Wheat yields can be influenced by the genetic make-up of the cultivar used, the production environment, and the interaction between cultivar and environment.

It is often claimed that the yield of wheat has increased significantly in the past three decades. Moreover, several researchers reported that much of this increase has been due to the introduction and wide spread use of higher yielding cultivars. The genetic improvement in wheat has resulted in shorter and stiffer straw, which has permitted the use of increased amounts of nitrogen fertilizer. These new cultivars are usually more resistant to diseases and insect pests. Such plant modifications have enabled growers to irrigate and fertilize wheat with less risk of losses from lodging and diseases.

Plant breeders have been aware of the important genotypic differences in adaptability, and they have tried to exploit them in their breeding programs. Adaptation is usually measured by performance in a given range of environments. Since it may be difficult to develop a cultivar for a wide range of environments, most plant breeders are concerned with the enhancement of local adaptation.

The objectives of this study were to study the nature of yield trends among International Winter Wheat Performance Nursery (IWWPN) cultivars, to estimate the genetic gain, and to determine the nature of any trend in test weight during the testing period at Stillwater.

CHAPTER II

LITERATURE REVIEW

A superior cultivar is the result of a combination of genes that interact well with the environment. The ability of some cultivars to perform well over a wide range of environmental conditions has long been appreciated by the agronomist and plant breeder. Briggs and Knowles (3) classified adaptation into two types: general adaptation, referring to the ability of a cultivar to do well over a wide range of environments and specific adaptation, referring to the ability of a cultivar to perform well in one environment.

Several researchers including Borlaug (2), Eberhart and Russel (4) and St. Pierre et al. (26) supported the advantage of selecting for wide adaptability. Moreover, Roy and Murty (17) have shown that bread wheat selected for synchronous tillering tend to be widely adapted. By studying his widely adapted Mexican wheat cultivar Borlaug (2) found that other characters such as insensitivity to day length and yield limiting factors such as resistance to lodging and disease are necessary if the cultivars are to adapt to a wide range of environments. Finlay and Shepherd (8), and Finlay and Wilkinson (9) studied the adaptation of barley cultivars in south Australia. According to their report, some genotypes were extremely sensitive to change in environment and produced above average yields only in favorable conditions. Other genotypes were very stable in their yield response to a range of environments, these produced above-average yields in poor environments.

The estimation of yield improvement rates measures the contribution of improved cultivars through time. O'Brien (15) reported the Victorian wheat yield trend in Australia from 1898 to 1977. When old and new cultivars were grown side by side and compared with a standard cultivar 'Olympic', a yield range from 75 to 108% of the check cultivar was measured, The older cultivars were clustered toward the lower end of the range. About one-third of the overall improvement in yield since 1898 was attributed to improved cultivars.

Frey (10) summarized the yield data of wheat and maize in the USA. According to his report during the course of this century, the yield potential of wheat and maize in the USA has increased by approximately 50% as a result of genetic improvement. Moreover, Fehr (6) indicated that genetic improvement of seed yields of many crops has been steady and large. From 1930 to 1980, yields of cereals and soybeans have been increased by 40 to 100 %. These gains in grain yield have been almost entirely to higher harvest index with little or no increase in total biological yield.

In a similar study Silvey (22) reported the yield improvement of wheat in the United Kingdom from 1947 to

1975. She assessed yields of currently grown cultivars relative to old standard cultivars. During this period wheat yield in the United Kingdom increased about 84%; 50% of the yield improvement could be attributable to genetic improvement. In another study, Austin et al. (1) compared modern English wheat cultivars with earlier cultivars under varying soil fertility conditions. According to their report modern wheat cultivars such as 'Hobbit' (released in 1977) out yielded 'Little Joss' (released in 1908) by nearly 40%. The newer cultivars were generally shorter in height and earlier in maturity than the older cultivars. Elliot (5) indicated that due to the adoption of new cultivars, wheat yields had increased 2% per year in the United Kingdom.

Russel (18) compared the yield trends in the USA and Australia for five crops from 1936 to 1968. According to his report all the USA crops have shown a significant linear trend with time. Linear regression of annual wheat yield versues time accounted for 80% of the variation of yields for the USA compared with 36% in Australia, possibly be due to the greater year-to-year variability in climate. He estimated that the genetic contribution to increased wheat yield in Australia was approximately 28%.

Salmon et al. (19) reported that improved cultivars accounted for 40% of the increased wheat production in the USA until 1950. Reitz and Salmon (16) estimated that 10 to 30% of the increase in yields in hard red winter wheat regions of the USA from 1931 through 1950 was due to genetic improvement. Jensen (12) estimated that the genetic improvement accounted for approximately 50% of the increase in New York wheat yields. Sim and Araji (23) attributed 55% of yield gain in western wheat regions of the USA to genetic factors. Hueg (11) indicated that not all the increased yield attributable to cultivars was due to genetic improvement. He estimated that of the 51 to 56% increase in Minnesota wheat yields due to cultivars, 26 to 29% resulted directly from breeding for yield, and the remainder was due to incorporating disease resistance into new cultivars.

Schmidt (21) summarized yield advances among nine uniform regional wheat nurseries from 1958 to 1980. By using a 3 year moving average and reporting yield gains as percentages of long-term check cultivars, he found a relative gain of 30, 30, 20, and 15% for the Southern Regional Performance Nursery, Western Uniform Regional Hard Red Winter Wheat Nursery, Uniform Regional White Winter Wheat Nursery and the Northern Regional Performance Nursery, respectively. Combining nine regional nurseries, he reported a 17% yield advantage in 1980 over the 1958 production levels. Feyerherm et al. (7) had reported that yields increased most where environmental constraints were smallest.

Kuhr et al. (13) reported the yield trends of International Winter Wheat Performance Nursery (IWWPN) cultivars from 1970 to 1983 for eleven testing sites. According to their report, predicted yield increased from 4075 kg/ha to 5946 kg/ha. From this gain 43% was due to genetic improvement, the reminder was due to improvement of management practices. On the other hand Warren (27) indicated that genotypic changes had little effects on New South Wales wheat yield trends. He attributed observed long term changes in yield mainly to economic factors affecting land use patterns.

Simmonds (24) has suggested that partitioning of yield improvement into genetic and non-genetic components ignores or assigns an insignificant role to genotype * environment interactions. Since production methods change over time and since genotypes differ in their response to environmental change, the question of G * E interactions becomes problematic in effecting a clean separation of benefits due to breeding and husbandry. Part of what appears to be a yield response to improved husbandry may be attributed to the fact that responsiveness to the new husbandry has been incorporated by breeders into their new cultivars.

CHAPTER III

MATERIALS AND METHODS

Materials

The International Winter Wheat Performance Nursery (IWWPN) was initiated in 1968. From its inception, it has been coordinated by USDA/ARS scientists at Lincoln, Nebraska. During the last 23 years, 310 winter wheat cultivars and 3 triticales from 30 countries have been tested (Table I). The IWWPN trial has been grown annually at some 30 stations worldwide including Stillwater, OK.

Every year the nursery was comprised of 30 entries, with half of the entries being replaced each year. Before 1974, the cultivars were tested for 3 years; since 1974 the cultivars have been tested for two years before removal from the nursery.

The data analyzed in this study were derived from IWWPN trials conducted from 1969 to 1991 in Stillwater. Grain yield data were examined to study adaptation. From a 3-year or 2-year testing period at Stillwater, the highest yielding cultivar (HY) was selected for statistical analyses. Yield and test weight trends were determined for the HY cultivars from each of six different countries: Bulgaria, Chile,

TABLE I

COUNTRIES AND RESPECTIVE NUMBER OF CULTIVARS AND YEARS REPRESENTED IN THE INTERNATIONAL WINTER WHEAT PERFORMANCE NURSERY (IWWPN) FROM 1969-1991

Country	No. of Cultivars	No. of Years
Argentina	2	4
Australia	3	6
Austria	7	11
Bulgaria*	27	19
Canada	3	6
Chile*	14	18
China	8	10
Czechoslovakia	4	8
England	8	10
E. Germany	2	4
Finland	4	6
France	4	8
Hungary*	27	18
Italy	9	13
Iran	1	2
Japan	7	12
Korea	4	7
Mexico	3	18
Netherlands	6	11
New Zealand	2	2
Poland	8	10
Romania*	18	19
South-Africa	2	2
Sweden	2	5
Switzerland	2	5
Turkey	5	7
USA*	71	23
USSR	16	23
W. Germany	10	14
Yugoslavia*	34	20
TOTAL	313	

* Selected for Trend Analysis.

Hungary, Romania, USA, and Yugoslavia. These were selected based on the number of years they were represented in the IWWPN trial system. These countries had been represented for 19, 18, 18, 19, 23, and 20 years, respectively. Moreover, during the testing period these countries had contributed 27, 14, 27, 18, 71, and 34 cultivars, respectively (Table I). The USSR contributed large number of cultivars for IWWPN. However, from 1981 to 1989 ,it had contributed only the check cultivar. Due to this reason the USSR was not included in this study.

Since 1969 the check cultivar in the IWWPN was Bezostaya-1, a widely adapted winter wheat from the USSR.

Field Layout and Nursery Management

The nursery of the IWWPN trial was arranged annually in a randomized complete block design with four replications. In the previous years plot size was about 1.5 m^2. However, plot size in the last seven years was 3.7m^2. The spacing between rows was 24 cm. The soil type in Stillwater was Norge loam, a fine silty, mixed thermic Udic Paleustolls. Planting was Usually in early October and harvested in mid-June. Harvesting was done by either a bundle harvester or a combine harvester. Planting, data collection, and harvesting were done by Agronomy Department personnel of the wheat breeding project.

Characters Evaluated

Grain yield and test weight were evaluated in this study. All the measurements were taken on a plot basis. The measurements were made as follows:

Grain Yield

Grain yield was determined for all replications. Previously the four center rows of a six row-plot were harvested. However, recently all rows of each plot were harvested to determine grain yield for analysis. Grain yield was taken as the weight of threshed grain from each plot and expressed as kilogram per hectare (kg/ha).

Test Weight

Cleaned grain samples was utilized for determination of test weight. Data was recorded in pounds per bushel and then converted to kilogram per hectoliter (kg/hl). Test weight was determined for one replication. In 1974, test weight measurement was not recorded for some cultivars, due to insufficient seed, and in 1982 the data were not recorded (Table X).

Statistical Analyses

Linear regression analyses were conducted on data from six countries in order to determine the presence or absence of significant linear trends for grain yield and test weight (Table I).

Mean yield of the highest yielding cultivar (HY) and the check cultivar were used in the regression analyses. A 3-year or 2-year moving mean of the HY cultivar and check were used to reduce the potentially distorting year effects attributable to climatic and other factors. The value for year in the moving mean was the upper most year, for example in 1969/71 the year value was 71. Yield values (kg/ha) of the HY cultivar expressed as percentage of Bezostaya-1 were plotted against time in order to determine the trends for grain yield. The same approach was used to determine the trends of test weight.

All the computations were made by the Statistical Analysis Systems (SAS) in the Department of Statistics, Oklahoma State University.

CHAPTER IV

RESULTS AND DISCUSSION

The linear regression analyses for grain yield and test weight are presented in tables II and III and the mean performance and percent of Bezostaya-1 values are presented in tables IV to IX. The linear coefficient measures the rate of yield increase per year. The significance level indicates whether the coefficient is significantly different from zero.

Bulgarian Cultivar Yield Trend

Linear regression of grain yield (% of Bezostaya-1) versues time was non-significant for the Bulgarian HY cultivars. This shows that there was no significant linear trend in the Bulgarian highest yielding cultivars during the testing period. The highest yielding cultivar from Bulgaria was Yantar. It produced 4125 kg/ha. The other best cultivars were Dobroudja-1 and Jasen, which gave 3699 and 3356 kg/ha, respectively (Table IV). When yield was converted to percent of Bezostaya-1, all the Bulgarian HY cultivars except Sadovo 1 and Loudogorka were better than Bezostaya-1. Prostor, Kataya A-1, and Pliska were measured 130%, 124%, and 123% of Bezostaya-1, respectively.

Chilean Cultivar Yield Trend

The linear regression of grain yield (% of Bezostaya-1) with time was not significant for the Chilean highest yielding cultivars. The possible reasons for lack of any linear trend could be adaptation problem, since Chile has a tropical type of climate, most of its cultivars did not perform well in colder winter climate. The other reason could be little genetic improvement in the Chilean cultivars.

yields ranged from 739 kg/ha to 2157 kg/ha. Laurel-INIA produced the highest yields; Budifen produced the lowest yields (Table V). All the Chilean HY cultivars were inferior to the check cultivar for grain yield. Relative to the check the range of yield was 22 to 87% of Bezostaya-1.

Hungarian Cultivar Yield Trend

Linear regression of grain yield (% of Bezostaya-1) against time was significant ($p<0.01$) for Hungarian highest yielding cultivars, indicating a positive linear trend during the testing period.

The increase in grain yield of the Hungarian HY cultivars relative to the check can be expressed by the equation $Y = 76.47+1.9(X)$ (Table II). In 1971 the predicted yield relative to the check cultivar was 78%. It advanced to 114% in 1990. Relative to Bezostaya-1, the genetic gain obtained was 36% (Fig. 1). Especially in the last 5 years, the Hungarian highest yielding cultivars were better than

TABLE II

REGRESSION OF YIELD (% OF BEZOSTAYA-1) VS. YEARS FOR THE HY CULTIVAR FROM THE IWWPN DURING 1969-1991 BASED UPON A LINEAR MODEL

Country	Intercept	Slope	R^2
Bulgaria	101.36	0.66[NS]	0.06
Chile	53.64	0.13[NS]	0.0
Hungary	76.47	1.90**	0.75
Romania	84.20	2.85**	0.76
USA	92.11	2.13**	0.37
Yugoslavia	95.44	0.61[a]	0.02[b]

** Significantly different from zero at the 0.01 probability level.
NS = Nonsignificant.
a Cubic model provided a satisfactory fit, where coefficients were -394.9 (linear), 62.7 (quadratic), and -4.6 (cubic).
b R^2 value for cubic model was 0.68.

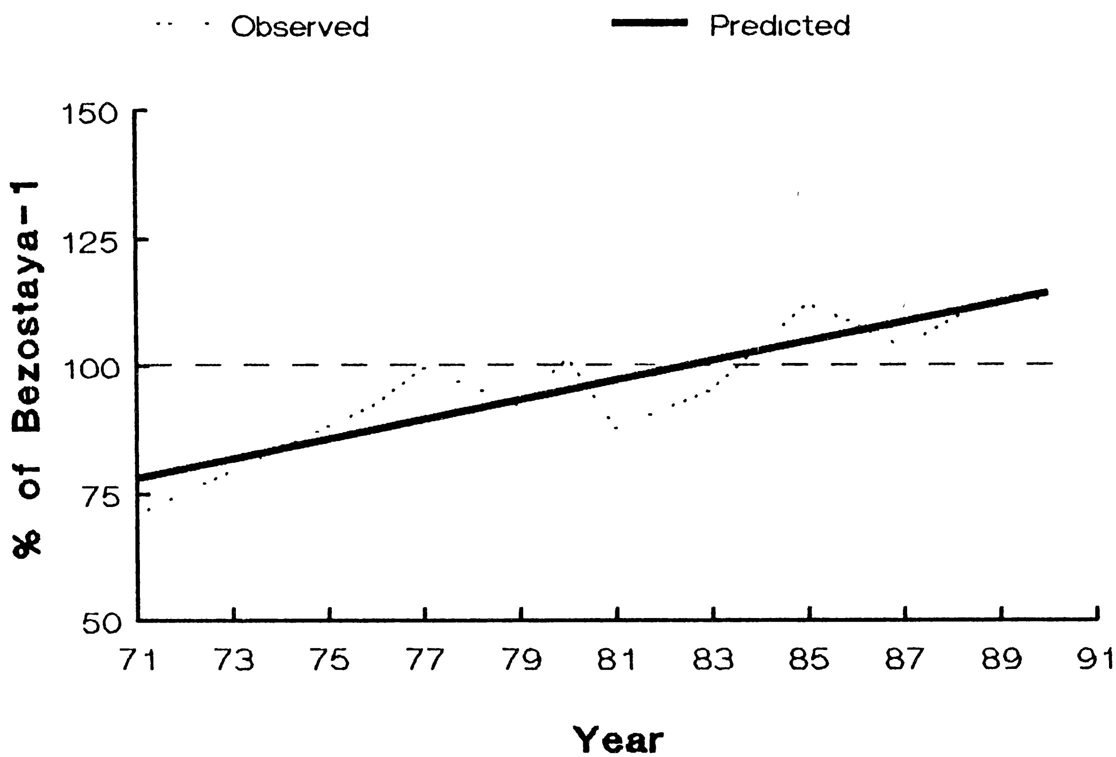

Figure 1. Yield Trends of the HY Cultivar of Hungary

the check cultivar. This indicates that those cultivars were rather well adapted to Stillwater, OK climatic conditions.

Grain yield in Hungarian cultivars ranged from 1977 kg/ha to 4299 kg/ha (Table VI). The highest yielding cultivar was GK-Protein and the low yielder was MV-7. The other best cultivars were GK-Boglar and Martonvasari-8, which gave 3932 kg/ha and 3798 kg/ha , respectively. Relative to the check cultivar MV-15, Martonvasari-8, and MV 16-85 were the top yielding cultivars (114%, 112%, and 113% of Bezostaya-1, respectively).

Romanian Cultivar Yield Trend

The linear regression of yield with time was significant ($p<0.01$) for the Romanian HY cultivars, indicating a positive linear trend during the testing period.

The increase in grain yield as a percent of the check can be expressed by the equation $Y = 84.2+2.85(X)$. The highest yielding cultivar advanced from 87% of Bezostaya-1 in 1974 to 136% of Bezostaya-1 in 1991. Relative to the check the genetic gain obtained in those cultivars was 49% (Fig. 2). Since 1980 the Romanian highest yielding cultivars out yielded the check cultivar. The higher genetic gain (49%) obtained in this study (Fig 2) demonstrate the genetic potential of Romanian cultivars to adapt well to Stillwater climate and soils.

Among the Romanian cultivars the best yielders were 9D-27-262, Lovrin-24 and Fundulea-4 (4611, 4562 and 3170

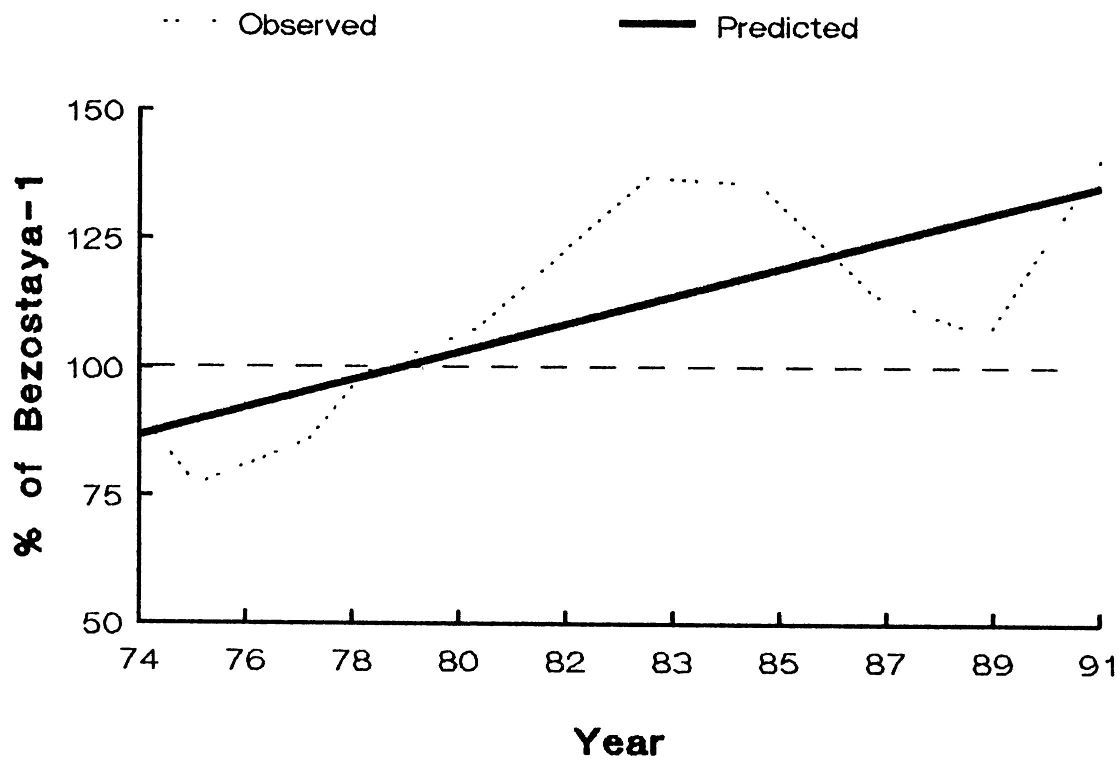

Figure 2. Yield Trends of the HY Cultivar of Romania

kg/ha), respectively (Table VII). When grain yield was expressed as a percent of Bezostaya-1, Flamura-85 was the highest and Favorit was the lowest yielder.

USA Cultivar Yield Trend

The linear regression of grain yield (% of Bezostaya-1) of the highest yielding cultivar against time was significant ($p < 0.01$). The coefficient of determination (r^2) value for the linear model was 0.37. The smaller r^2 value possibly reflected the highest mean yield variation from year to year in the USA highest yielding cultivars.

The linear increase in grain yield as percent of Bezostaya-1 can be expressed by the equation $Y = 92.11 + 2.13(X)$. The predicted grain yield in 1971 was 94% of Bezostaya-1 and in 1991 it was 137% of Bezostaya-1 (Fig. 3). The genetic gain obtained in this study was 43%. In the last 23 years, yields of the USA cultivars ranged from 1286 kg/ha to 4229 kg/ha (Table VIII). The highest yielding cultivar was Siouxland followed by Florida-302 and Auburn with yields of 4043 kg/ha and 3990 kg/ha respectively. When yield was expressed as a percent of Bezostaya-1, Cardinal was the highest and Blueboy was the lowest yielder.

Yugoslavian Cultivar Yield Trend

Linear regression of grain yield with time was not significant for Yugoslavian cultivars. However, the cubic equation model was significant at the 5% level of significance. This indicates that there was a great degree

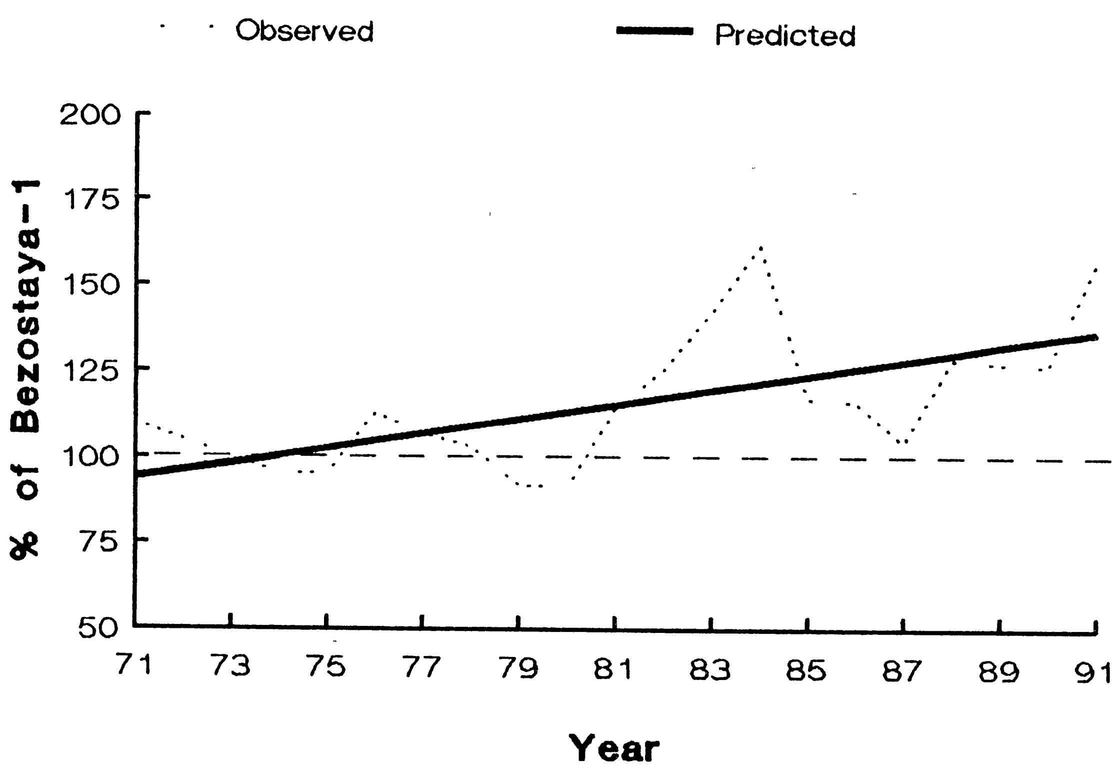

Figure 3. Yield Trends of the HY Cultivar of the USA

of mean yield variability from year to year in the Yugoslavian highest yielding cultivars (Fig 4). The probable cause for yield variability might have been poor adaptation to Stillwater climate, especially winter temperature and soils.

The top yielding Yugoslavian cultivars were Sava (NS-611) , NS-2704 and NSR-1 yielding 4781 kg/ha, 4143 kg/ha and 4058 kg/ha, respectively (Table IX). Relative to Bezostaya-1, Sava (NS-611), NS 18-89A, and NS-2704 were the top yielding cultivars.

Generally the estimate of genetic gain in this study (Fig. 1, 2, and 3) were in agreement with those reported by Jensen (12), Sim and Araji (23), Schmidt (21), and Kuhr et al. (13) for IWWPN cultivars. Their estimates ranged from 16% to 55%. The probable reason for this low genetic gain by Kuhr et al. might be that they used the most productive cultivar in each testing period regardless of the origin: hence, their estimation seemed some what general. The second reason might be their study included only the period from 1970 to 1983; the contribution of improved cultivars since 1984 were not included in their study.

Trends in Test Weight

The second parameter investigated in the study was test weight. This character has been recorded for the last 23 years along with grain yield in the Stillwater, OK trials. Relative to the check, all HY Bulgarian cultivars had low test weight values. Among the cultivars, Roussalka and

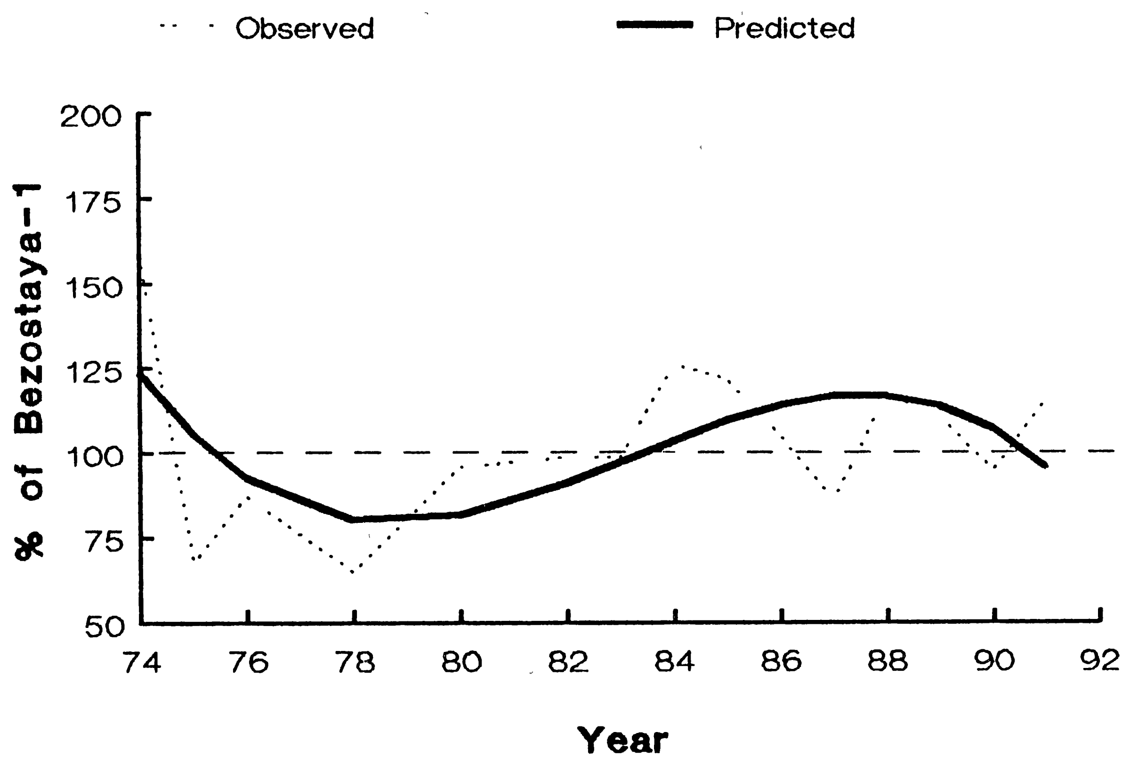

Figure 4. Third Degree Polyn. of the HY Cultivar of Yugo.

Loudogarka had the highest test weights, with values of 86.4 and 75.3 kg/hl, respectively (Table IV).

Most of the Chilean cultivars were lower in test weight. The highest value was 73.3 kg/hl, obtained from cultivar Labriego-INIA. Relative to the check, all the cultivars from Chile were found to be poor in test weight (Table V).

The test weight values for Hungarian HY cultivars ranged from 60 to 78.6 kg/hl. Bankuti-1201 and MV-7 had the highest and lowest values respectively. Relative to the check all the cultivars from Hungary were inferior in test weight (Table VI) .

The range of test weights for the Romanian HY cultivars was 69.7 to 87.6 kg/hl. Cultivars which had the highest measurement were Dacia and Lovrin 24. They measured 87.6 and 77.1 kg/hl, respectively (Table VII).

The range of test weight in the USA highest yielding cultivars was between 66.3 kg/hl and 91.6 kg/hl. The top cultivars in terms of test weight measurement were NE-701132, Arthur and TAM-W-105, Those cultivars had a value of 91.6, 78.7 and 75.5 kg/hl, respectively. All USA highest yielding cultivars except TAM-W-105, NE-75414 and Bounty-100 were inferior to the check cultivar (Table VIII).

Among Yugoslavian cultivars Sava (NS-611) and NS-2699 produced the best test weight measurements. They had a values of 82.9 and 77.3 kg/hl, respectively (Table IX). Relative to the check all the Yugoslavian cultivars except NS 18-89A were lower in test weight.

The linear regression of test weight (% of Bezostaya-1) against time was not statistically significant for any of the countries. This suggested that test weight has not increased simultaneously with yield in the IWWPN cultivars during the testing period (Table III). According to Smith (25) it has been observed that, on an emperical basis, no strong relationship between high yield and test weight values in wheat exists.

One possible reason for lower test weights of the IWWPN cultivars might be due to the fact that little attention has been given by breeders to improve test weight as compared to yield potential.

TABLE III

LINEAR REGRESSION ANALYSES OF TEST WEIGHT (% OF BEZOSTAYA-1) VS.YEARS FOR THE HIGHEST YIELDING CULTIVAR FROM IWWPN TRIAL OF 1969-1991 IN STILLWATER

Country	Intercept	Slope	R^2
Bulgaria	95.34	0.06^{NS}	0.02
Chile	82.32	0.22^{NS}	0.02
Hungary	95.96	0.13^{NS}	0.04
Romania	96.07	0.21^{NS}	0.09
USA	94.62	0.18^{NS}	0.07
Yugoslavia	93.14	0.20^{NS}	0.06

^{NS} = Nonsignificant.

CHAPTER V

SUMMARY AND CONCLUSIONS

The International Winter Wheat Performance Nursery (IWWPN), initiated in 1968, has been grown annually at some 30 stations worldwide including Stillwater, OK. During the last 23 years, 310 winter wheat cultivars and 3 triticales from 30 countries have been tested in this nursery. The nursery is comprised of 30 entries arranged in a randomized complete block design with four replications. Before 1974, cultivars were tested for three years: since 1974, entries in IWWPN have been tested for two years before removal from the nursery; half of the entries being replaced each year.

The statistical method used in this study was regression analyses of yield values of the highest yielding cultivars expressed as percentages of a standard check and plotted against time. In order to enhance the validity of the analyses, six countries that had been represented at least for 18 years in the IWWPN trial were selected for the analysis. Those countries (Bulgaria, Chile, Hungary, Romania, USA and Yugoslavia) contributed 27, 14, 27, 18, 71 and 34 cultivars, respectively. Data from the IWWPN trial in Stillwater were analyzed to determine the presence or absence of a linear trend for grain yield and test weight.

Relative to the long-term check, Bezostaya-1, grain yields of the highest yielding cultivars of Hungary, Romania, and USA showed a significant linear trend ($p < 0.01$). The increase in grain yield as percent of Bezostaya-1 can be expressed by the regression equation $Y = 76.47 + 1.9(X)$, $Y = 84.2 + 2.85(X)$ and $Y = 92.11 + 2.13(X)$ for Hungary, Romania, and the USA HY cultivars, respectively. The predicted yield of the highest yielding cultivars from Hungary advanced from 78 to 114% of Bezostaya- 1. The Romanian highest yielding cultivar advanced from 87 to 136% of Bezostaya-1. The USA highest yielding cultivar advanced 43 percentage points from 94 to 137% of Bezostaya-1. Relative to the check, the genetic gain obtained in this study was 36, 49, and 43% for Hungary, Romania, and USA highest yielding cultivars, respectively. The highest yielding cultivars from Bulgaria, Chile, and Yugoslavia did not show significant linear trends. The second parameter, test weight (% of Bezostaya-1) values against time did not show significant linear trends for any country.

This study suggests that cultivars from Hungary and Romania in general have good adaptation in Stillwater. Germplasms from these two countries should prove useful in the future wheat breeding programs in Oklahoma.

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APPENDIX

TABLES

TABLE IV

MEAN GRAIN YIELD, TEST WEIGHT AND PERCENT OF BEZOSTAYA-1 FOR BULGARIAN HIGHEST YIELDING CULTIVARS FROM THE IWWPN TRIAL GROWN IN STILLWATER, OK

Year	Cultivar	Yield KG/HA	Tst Wt KG/HL	% of Bezo-1 Yield	% of Bezo-1 Tst Wt
72/74	Roussalka	3450	86.4	115.2	93.6
77/78	Sadovo-1	2837	73.2	99.8	97.0
80/81	Trakia	2462	73.3	102.4	95.7
81/82	Loudogarka	2696	75.3	95.3	95.9
83/84	Kataya A-1	3026	71.4	123.9	99.8
84/85	Dobroudja-1	3699	72.9	109.0	98.7
85/86	Yantar	4125	71.2	114.0	96.1
87/88	Pliska	2939	69.0	122.6	90.5
88/89	Jasen	3356	74.8	104.8	97.2
89/90	Pobeda	2688	72.6	101.4	96.4
90/91	Prostor	2641	70.8	130.6	97.3

TABLE V

MEAN GRAIN YIELD, TEST WEIGHT AND PERCENT OF BEZOSTAYA-1 FOR CHILEAN HIGHEST YIELDING CULTIVARS FROM THE IWWPN TRIAL GROWN IN STILLWATER, OK

Year	Cultivar	Yield KG/HA	Tst Wt KG/HL	% of Bezo-1 Yield	% of Bezo-1 Tst Wt
72/74	Carifen-12	1815	70.3	60.5	76.2
74/75	Likafen	1030	73.2	73.9	99.7
78/79	Budifen	739	61.0	22.2	79.1
80/81	Huenufen	935	58.3	29.0	76.2
82/83	Lucero-INIA	1275	58.2	60.9	84.5
83/84	Quilamapu 25-77	2143	56.4	87.7	78.8
84/85	Labriego-INIA	1555	73.3	45.8	92.2
85/86	Quilamapu 23-77	1255	66.7	34.6	89.4
86/87	Lancero-INIA	1488	64.5	59.5	86.8
87/88	Talafen	1191	62.0	49.7	81.3
88/89	Laurel-INIA	2157	70.9	68.1	92.1

TABLE VI

MEAN GRAIN YIELD, TEST WEIGHT AND % OF BEZOSTAYA-1
FOR HUNGARIAN HIGHEST YIELDING CULTIVARS
FROM THE IWWPN TRIAL GROWN
IN STILLWATER, OK

Year	Cultivar	Yield KG/HA	Tst Wt KG/HL	% of Bezo-1 Yield	% of Bezo-1 Tst Wt
69/71	Bankuti-1201	2502	78.6	71.0	89.0
75/76	Martonvasar-2	2227	74.5	92.6	97.9
76/77	Martonvasar-3	3532	77.5	99.6	98.5
78/79	Martonvasari-4	3102	75.3	92.4	97.8
79/80	GK-Protein	4299	77.5	101.5	99.2
80/81	Martonvasari-6	2824	73.4	87.8	95.9
82/83	MV-7	1977	60.0	95.4	87.1
84/85	Martonvasari-8	3798	71.2	112.3	96.3
85/86	GK-Boglar	3932	69.3	108.3	92.8
86/87	Martonvasari-12	2580	69.0	103.6	92.9
88/89	MV-15	3628	71.5	114.5	93.0
89/90	MV 16-85	3001	69.3	112.9	92.0

TABLE VII

MEAN GRAIN YIELD, TEST WEIGHT AND % OF BEZOSTAYA-1
FOR ROMANIAN HIGHEST YIELDING CULTIVARS
FROM THE IWWPN TRIAL GROWN
IN STILLWATER, OK

Year	Cultivar	Yield KG/HA	Tst Wt KG/HL	% of Bezo-1 Yield	% of Bezo-1 Tst Wt
72/74	Dacia	2738	87.6	91.4	94.9
74/75	Favorit	1078	70.3	77.3	95.8
76/77	F 26-70	3055	77.0	86.1	98.0
77/78	F 54-70	2820	74.4	99.2	98.6
79/80	Lovrin-24	4562	77.1	107.7	98.7
82/83	F 29-76	2868	74.4	137.1	108.0
84/85	9 D-27-262	4611	69.7	135.9	94.4
86/87	Fundulea-133	2491	74.3	114.3	95.6
88/89	Fundulea-4	3170	77.0	106.5	101.3
90/91	Flamura-85	2842	72.8	140.5	100.0

TABLE VIII

MEAN GRAIN YIELD, TEST WEIGHT AND % OF BEZOSTAYA-1
FOR THE USA HIGHEST YIELDING CULTIVARS
FROM THE IWWPN TRIAL GROWN
IN STILLWATER, OK

Year	Cultivar	Yield KG/HA	Tst Wt KG/HL	% of Bezo-1 Yield	% of Bezo-1 Tst Wt
69/71	Arthur	3874	78.7	109.87	89.0
72/74	NE 701132	2864	91.6	95.5	99.3
74/75	Blueboy	1286	67.7	95.18	92.3
75/76	Sentinel	2720	73.5	113.14	96.5
76/77	Blueboy	3804	74.1	107.03	94.2
77/78	Lindon	2938	75.2	103.36	99.7
78/79	CI 13449/Centurk	3006	69.4	91.94	94.6
79/80	Blueboy	3878	71.4	91.52	91.4
80/81	TAM-W-105	3675	74.8	114.44	97.7
81/82	TAM-W-105	3020	75.5	125.59	100.8
82/83	Brule (NE-75414)	2966	66.3	142.62	100.9
83/84	Bounty H.100	3951	75.5	161.76	105.6
84/85	Auburn	3990	73.9	117.58	100.1
85/86	Siouxland	4229	74.5	116.45	99.8
86/87	Quantum-555	2602	71.1	104.48	95.7
87/88	Bounty-205	3088	73.1	128.81	95.9
88/89	Florida-302	4043	72.5	127.55	94.2
89/90	Dynasty	2479	70.2	126.80	93.3
90/91	Cardinal	3178	70.1	157.10	97.5

TABLE IX

MEAN GRAIN YIELD, TEST WEIGHT AND % OF BEZOSTAYA-1 FOR YUGOSLAVIAN HIGHEST YIELDING CULTIVARS FROM THE IWWPN TRIAL GROWN IN STILLWATER, OK

Year	Cultivar	Yield KG/HA	Tst Wt KG/HL	% of Bezo-1 Yield	% of Bezo-1 Tst Wt
72/74	Sava (NS-611)	4781	82.9	159.4	89.9
74/75	Zg 5996/66	946	68.5	67.9	93.3
75/76	Biserka	2099	72.8	87.3	95.6
77/78	Zg-4293-73	1851	68.4	65.1	90.6
79/80	NSR-1	4058	74.9	95.8	95.9
81/82	NS-2699	2369	77.3	98.8	98.4
82/83	NS 18-30	2062	65.8	98.6	95.5
83/84	NS 18-89A	3088	75.3	126.4	105.3
84/85	NS-2704	4143	73.7	122.1	99.8
85/86	NS-1899	3760	73.6	105.5	98.6
86/87	Zg 7057/79	2139	68.3	85.9	91.9
87/88	NS-2985	2817	75.1	117.5	98.5
88/89	Kosava	3513	76.1	110.8	98.9
89/90	NS 65-84	2526	66.2	95.1	87.9
90/91	ZG 920/85	2338	69.7	115.6	95.8

TABLE X

GRAIN YIELD AND TEST-WEIGHT FOR THE NURSERY MEAN AND BEZOSTAYA-1 IN STILLWATER,OK, 1969 to 1991

Year	Yield (kg/ha)		Test Weight (kg/hl)	
	Nursery Mean	Bezostaya-1	Nursery Mean	Bezostaya-1
1969	3081	4183	76.0	80.6
1970	2563	3245	72.6	76.2
1971	2656	3343	76.5	81.0
1972	2238	3052	95.1	103.6
1973	3546	4893	74.5	81.0
1974	747	1051	----	75.2
1975	1559	1736	70.3	73.4
1976	2657	3069	74.2	78.8
1977	3532	4027	76.1	78.4
1978	1438	1658	67.0	72.5
1979	4358	4880	76.5	81.7
1980	2990	3595	69.1	74.6
1981	1900	2827	71.3	78.6
1982	1873	1982	----	----
1983	2136	2200	63.7	68.9
1984	3354	2684	72.3	74.1
1985	3339	4102	69.4	73.7
1986	2453	3161	69.3	75.6
1987	1670	1820	67.2	73.9
1988	3014	2972	75.4	78.6
1989	2926	3362	68.7	75.3
1990	2209	1953	69.7	75.2
1991	2365	2090	60.0	70.5

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