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FACTORS AFFECTING VARIETAL PERFORMANCE IN THE INTERNATIONAL WINTER WHEAT PERFORMANCE NURSERY[1]

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SUMMARY

Relationships between agronomic traits, grain quality, and diseases of winter wheat varieties, and climatological factors within classes of environments based on yield level were examined. Sixteen winter wheat varieties grown in the International Winter Wheat Performance Nurseries of 1969, 1970, and 1971 were utilized for the study.

Varieties grown in high-yielding, non-irrigated environments had longer grain maturation periods than in low-yielding, non-irrigated environments. Varieties grown in irrigated environments did not show this relationship. Increased plant height and lodging occurred in high-yielding, irrigated and non-irrigated environments. Disease incidence generally increased with increasing yields for both irrigated and non-irrigated environments.

The International Winter Wheat Performance Nursery (IWWPN) was designed to test the adaptation of winter wheat varieties over a range of latitudes, soil fertility conditions, water management and disease complexes. Nursery sites throughout the world were selected to sample the major winter wheat production environments. Performance data from such an array of environments has afforded excellent opportunity to study the adaptation characteristics of winter wheat.

Three stability parameters—mean, regression of individual variety performance on nursery mean performance, and deviation from regression—were utilized to describe the performance of varieties grown in the IWWPN in 1969 and 1970.[3] They were computed for each of several performance traits. This statistical technique does not permit the influence of one trait on another to be measured, since stability parameters were computed for each trait according to its own particular ranking of environments.

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[3]STROIKE, J. E., and V. A. JOHNSON 1972. Winter wheat cultivar performance in an international array of environments. Nebr. Res. Bull. 251.

In this study 70 environments were classified according to the yield of the 16 winter wheat varieties listed in Table 1. Non-irrigated nurseries were classified separately from irrigated nurseries. The year in which a nursery was grown was disregarded. Means of agronomic, disease, grain-quality and climatological factors were computed for each yield class and reported in Tables 2 and 3.

TABLE 1. Varieties selected from the International Winter Wheat Performance Nurseries in 1969, 1970, and 1971

Variety	Origin	Variety	Origin
Arthur	Indiana	Parker	Kansas
Atlas 66	North Carolina	San Pastore	Italy
Benhur	Indiana	Scout 66	Nebraska
Bezostaya 1	USSR	Sturdy	Texas
Blueboy	North Carolina	Timwin	Wisconsin
Felix	Netherlands	Triumph 64	Oklahoma
Fertodi 293	Hungary	Yorkstar	New York
Heine VII	Germany	Yung Kwang	Korea

TABLE 2. Agronomic and grain-quality data for environments combined according to mean yield of 16 selected varieties in the International Winter Wheat Performance Nurseries grown in 1969, 1970, and 1971

Yield range	Environments	Yield mean	Test wt.	Date of Flowering	Date of Ripening	Maturation period	Plant ht.	Lodging	Protein	Lysine per protein
q/ha	no.	q/ha	kg/hl	days from Jan.1		days	cm	%	%	%
Non-irrigated (53 environments)										
10-20	6	15.2	77.9	136	169	33	92	1	14.7	2.92
20-30	11	26.8	71.6	136	175	39	89	16	16.1	2.83
30-40	23	34.4	76.8	149	189	40	98	25	15.1	2.88
40-50	7	45.5	78.4	154	194	40	102	12	13.9	3.00
50-60	6	54.9	79.5	148	198	50	98	30	14.3	2.92
Mean		35.4	76.8	145	152	40	96	17	14.8	2.91
Irrigated (17 environments)										
18-40	9	32.2	76.0	135	170	35	98	9	15.6	2.86
40-65	8	51.3	76.6	136	170	34	106	25	15.1	2.88
Mean		41.8	76.3	136	170	35	102	17	15.4	2.87

In the non-irrigated nurseries, high yield was associated with longer periods of grain maturation. The period of maturation tended to be earlier in the year in lower yielding environments. Plant height and lodging tended to increase as yields increased in the dryland experiments. Surprisingly, the amount of reported precipitation during the crop year decreased as yield level increased.

More complete information on environmental factors such as temperature means and variance is needed to fully interpret these data.

TABLE 3. Disease and climatological data for environments combined according to mean yield of 16 selected varieties in the International Winter Wheat Performance Nurseries grown in 1969, 1970, and 1971

Yield range	Environments	Yield mean	Disease infection: Stripe rust	Leaf rust	Stem rust	Mildew	Precipitation	Elevation	Latitude (N)
q/ha	no.	q/ha	%	%	%	%	mm	m	
Non-irrigated (53 environments)									
10-20	6	15.2	7.4	14.3	0.4	0	750	753	38°32'
20-30	11	26.8	6.4	15.6	5.6	9.9	539	314	40° 3'
30-40	23	34.4	4.6	13.5	9.1	16.9	554	348	42°27'
40-50	7	45.5	12.1	9.3	12.0	11.0	525	322	47° 4'
50-60	6	54.9	2.1	20.0	16.5	27.6	483	204	47°29'
Mean		35.4	6.5	14.5	8.7	13.1	570	388	43° 7'
Irrigated (17 environments)									
18-40	9	32.2	19.7	5.4	1.3	5.6	---	628	40°56'
40-65	8	51.3	14.9	15.6	12.1	5.0	---	1063	39° 9'
Mean		41.8	17.4	10.2	6.1	5.3	---	832	40° 2'

Low-yielding non-irrigated nurseries tended to occur at higher elevations and lower latitudes than high-yielding non-irrigated nurseries. Nurseries yielding from 10 to 20 q/ha were located at latitudes ranging from 34°19' to 44°30' N with an average of 38°32'. Nurseries yielding from 50 to 60 q/ha were located at latitudes ranging from 42°24' to 55°35' N with an average of 47°29'. The average elevation of the high-yielding nurseries was 204 meters compared to 753 meters for the low-yielding nurseries.

In the irrigated nurseries, low- and high-yielding environments were at approximately the same average latitude. The higher elevations produced higher yields. Latitudes ranged from 32°0' to 52°30' N for low-yielding, irrigated environments, and from 34°33' to 45°5' N for high-yielding, irrigated environments.

Disease incidence generally increased with increasing yields. This was true for both irrigated and non-irrigated nurseries. Stripe rust and leaf rust did not vary as greatly as did stem rust and mildew.

Nurseries not reporting disease severity or reaction were considered as zero severity, and those reporting only the reaction could not be included in the disease severity mean. Non-irrigated nurseries yielding from 30 to 40 q/ha ranged from 9.9 to 36.6% severity among the 5 sites reporting stripe rust; whereas 12 sites reporting leaf-rust severity ranged from 1.7 to 60.1%.

The association of high yield with increased plant height and lodging was evident in irrigated nurseries, as it was in dryland nurseries. An advantage of a longer grain-maturation period could not be demonstrated in irrigated nurseries.

Grain protein and yield tended to be inversely related, but lysine expressed as a percent of protein remained relatively unchanged across environmental classes.

The kind of analyses reported here can be useful for recognizing various relationships between environmental factors and plant responses. They point out the need for reporting more precise information concerning other important environmental factors, such as soil characteristics and fertility, and more complete climatological data.