COMPARISON OF LEAF SIZE AND LEAF LIFE-SPAN AMONG SELECTED TALL AND SEMIDWARF SPRING WHEAT CULTIVARS [1]

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INTRODUCTION

A number of workers have reported high correlations between leaf area or leaf area x leaf life-span and wheat yield (Lupton et al. 1967; Puckridge 1969; Puckridge and Ratkowsky 1971; Voldeng and Simpson 1967; Welbank et al. 1966). Leaf area x leaf life-span is a fundamental index of photosynthetic potential; it has been used to estimate losses from plant disease and to develop disease loss forecasts (Buchenau 1970; Van der Plank 1963). With reference to predicting rust losses in wheat in South Dakota, the basic information from which the system was derived came from experiments on spring and winter wheat cultivars of "normal" height and maturity. Early maturing semidwarf wheat cultivars are commercially available, and it is possible that such cultivars will eventually dominate the wheat acreage in South Dakota. This study was undertaken to compare pertinent leaf characteristics of some standard and semidwarf spring wheat cultivars in order to determine if the system for predicting rust losses is appropriate for use on the semidwarfs.

MATERIALS AND METHODS

Wheat cultivars Chris, Waldron, Era, Bonanza, World Seeds 1809, and Bounty 208 were grown in an autoclaved sand-peat mixture (UC Mix "C", Baker 1957), 5 plants per pot, on a greenhouse bench at approximately 22 C. Pertinent features of these cultivars are given in Table 1. Each pot was an experimental unit, and the experiment was replicated 3 times in a randomized complete block design. When each successive leaf reached a length of 10 cm, it was tagged and dated; as each leaf became 50 percent dead, the date was recorded and the life span of each leaf was defined as the time interval between the two dates. Data from tillers are not included in this report.

Leaf areas were calculated by the formula L x W x 0.8 (Voldeng and Simpson, 1967). The area of each leaf was multiplied by the

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life span of the leaf, the resultant leaf area x leaf life-span being an indicator of the total photosynthetic potential of that portion of the foliage.

RESULTS

Plants grew rapidly under the relatively constant, warm greenhouse environment. Most of the cultivars headed about 10 days earlier than they do in the field. Era was very late compared to the other cultivars; W.S. 1809 was very early (Table 1).

Cultivars differed in the number of leaves they produced (Table 2). The late maturing cultivars Chris, Waldron, and Era produced 9 leaves; the early maturing cultivars World Seeds 1809, Bounty 208, and Bonanza produced 7 or 8 leaves. Leaf production rates were relatively similar for all cultivars except World Seeds 1809; this cultivar produced leaves 1.5 times faster than did the other cultivars. Era produced leaves at the same rate as the other cultivars in spite of the fact that it headed later.

Through the first 7 leaves, successive leaves were each generally larger than the preceding leaf. Chris had significantly more total leaf area than all the other cultivars; Waldron and Era had more than the early maturing cultivars.

Life span of successively formed early leaves gradually increased from 26 days for the first leaf to 38 days for the 4th con-

TABLE 1

Maturity and Height Characteristics of Six Spring Wheat Cultivars

Cultivar	Description	Ht[b]	Heading date[a] Field[b]	Heading date[a] Greenhouse
		(cm)	(days)	
Chris	Tall, moderately late	98	65	56
Waldron	Tall, moderately late	93	63	56
Era	Semidwarf, late	78	67	65
Bonanza	Semidwarf, mod. late	72	64	51
World Seeds 1809	Semidwarf, early	71	60	42
Bounty 208	Semidwarf, early	70	61	50

[a]Heading date expressed as days from planting
[b]1971 regional field means

TABLE 2

Time of Leaf Emergence of Six Spring Wheat Cultivars[a]

Order of Leaf Appearance	CULTIVAR					
	Chris	Waldron	Era	Bonanza	1809	Bounty 208
	days to reach 10 cm.[b]					
1	12	12	13	12	12	13
2	17	18	18	18	17	18
3	22	22	21	21	21	21
4	27	26	25	25	23	27
5	31	32	32	31	29	32
6	38	38	37	35	30	36
7	43	43	41	39	36	41
8	47	46	46	43	....	....
9	55	53	50	....	....	....
Total Leaves	9	9	9	8	7	7
Rate of growth (leaves/day)	0.16	0.17	0.18	0.19	0.27	0.17

[a]Each entry is a mean of 15 leaves

[b]Days from planting

secutive leaf. After this, leaf life span generally increased further, but the increase varied considerably between cultivars and proximity to the flag leaf. In most cultivars the 3rd and 4th leaf below the inflorescence had the longest life span.

From our experience in examining hundreds of thousands of wheat culms, it has become clear that the 3 top leaves produced almost all of the photosynthetic input for yield. The data from the top 3 leaves were analyzed as a 3 leaf x 6 cultivar factorial. In the following discussion, the ultimate (top leaf) is called the flag leaf; the penultimate, the 2nd leaf; and the antipenultimate, the 3rd leaf.

For all cultivars, the 3rd leaf was the smallest of the three, the flag leaf and 2nd leaf were of the same size. There was a significant leaf x cultivar interaction, especially because of the small flag leaf of Bonanza (Table 3). Chris had the largest leaves of all

TABLE 3

Leaf Area of the Top Three Leaves of Six Spring Wheat Cultivars

Leaf	CULTIVAR						
	Chris	Waldron	Era	Bonanza	W. S. 1809	Bounty 208	Leaf Mean
Flag	29	21	22	15	23	21	22[a]
2nd	29	20	22	21	19	20	22[a]
3rd	24	21	21	18	17	19	20
Cultivar Mean	27.4	21.1[ab]	21.6[a]	18.0[d]	19.7[c]	19.9[bc]	

[a]Margin means with the same letter are not significantly different from one another at the 5 percent level using Duncan's multiple range test.

cultivars; the leaves of Era and Waldron were significantly larger than those of the early maturing cultivars.

For all cultivars, flag leaves were significantly shorter-lived than the 2nd or 3rd leaves (Table 4). For all leaves, Chris had the longest leaf life-span of all cultivars, but not statistically longer than World Seeds 1809 or Bounty 208. Waldron had the shortest

TABLE 4

Life Span of the Top Three Leaves of Six Spring Wheat Cultivars

Leaf	CULTIVAR						
	Chris	Waldron	Era	Bonanza	W. S. 1809	Bounty 208	Leaf Mean
	Days						
Flag	44	41	42	41	45	43	43
2nd	49	45	45	43	48	47	46[a]
3rd	52	42	47	47	49	50	48[a]
Cultivar Mean	48[a]	42[d]	45[bc]	44[cd]	47[ab]	46[abc]	

[a]Margin means with the same letter are not significantly different from one another at the 5 percent level using Duncan's multiple range test.

TABLE 5

Photosynthetic Potential of the Top Three Leaves of Six Spring Wheat Cultivars

	CULTIVAR						
Leaf	Chris	Waldron	Era	Bonanza	W. S. 1809	Bounty 208	Leaf Mean
				cm^2-days			
Flag	1258	919	925	615	1047	883	941[a]
2nd	1437	891	1001	899	901	922	1008[b]
3rd	1267	853	962	859	830	953	954[ab]
Var. Mean	1321	888[a]	963[a]	791[b]	926[a]	919[a]	

[a]Margin means with the same letter are not significantly different from one another at the 5 percent level using Duncan's multiple range test.

leaf life-span of any cultivar tested. There was no significant leaf x cultivar interaction.

Leaf photosynthetic potentials, expressed as cm^2-days, reflect both leaf size and the time span during which the leaf was functional. The second leaf had significantly more photosynthetic potential than the flag leaf, although the difference was only about 5 per cent (Table 5). Chris was the outstanding cultivar, surpassing the nearest cultivar, Era, by 37 percent. The large leaf area and, to a lesser extent, the long leaf-life of this cultivar contributed to its superior photosynthetic potential.

DISCUSSION

Size and life-span of the top 3 leaves of spring wheat were not associated with either short stature or early maturity in this study. Thus, there is good reason to believe that the South Dakota system for predicting rust epidemics and formulating recommendations for chemical control is equally appropriate for use on early maturing, semi-dwarf wheat cultivars as for cultivars of "standard" maturity and height.

Leaf durations observed in this greenhouse study were somewhat longer than the 40 day leaf durations considered as average for South Dakota wheats under field conditions. Absence of stress in the greenhouse is a logical explanation for this phenomenon; we have observed field leaf durations up to 45 days occasionally, and frequently as short as 30 days when plants were under stress.

The distinct photosynthetic advantage of Chris was easily identified by leaf size. However, leaf area x life-span is a more suitable index of photosynthetic input under field conditions where leaf diseases and other leaf stresses are common.

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