An Evaluation of Polycross Progenies for Leaf and Plant Characteristics in Winter Active Tall Fescue
(*Festuca arundinacea* Schreb.)

I. Summer Forage Phase

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I. Introduction

As a medium fertility requiring forage species, tall fescue has polymorphism and wide adaptability to various soil and climatic conditions. Since the extended forage production period and heat tolerance are primary objectives of forage breeding in Korea, polycross progenies of winter active genotypes selected on hot and dry climate of southern Oregon, U.S.A. might be useful source materials for the initiation of a tall fescue breeding program.

There are many different ideas on the use of polycross progeny testing as an evaluation of breeding materials.

Shaepman\(^9\) pointed out three advantages of the polycross progeny test: (1) polycross progeny gives an indication of general combining ability which is more important than specific combining ability for the production of synthetics; (2) the polycross is an easy way to harvest seed for a reliable genotypic evaluation of mother clones; and (3) with the polycross, the breeder obtains seed as a similar to the normal multiplication of seed.

Grauman\(^6\) proposed that the polycross method was particularly better than the diallel analysis with species which have floral habits unadapted for large scale controlled crossing by bagging method.

Wit\(^{13}\) concluded that polycross progeny test is more reliable than open-pollinated progeny test and disadvantage of diallel cross progeny test is offset in polycross progeny test from his study in space-planted perennial ryegrass.

However, Briggs and Knowles\(^{22}\) warn that pollination may not be random because of different characteristics of the lines or clones with respect to (1) volume of pollen produced; (2) timing of pollen shedding; (3) differential cross compatibilities; (4) level of selfing; (5) plant height; and lodging.

Comparisons among various progeny tests have been accomplished by Buckner\(^{23}\) and Echeverri\(^{49}\).

The true value of a progeny tests is in the effectiveness of selecting the genotypes
which can be used practically in the development of synthetics to produce improved varieties. The effectiveness of the progeny tests varied to some extent from trait to trait and from population to population.

For the plant characteristics in the connection of photosynthesis, leaf area, leaf dry weight and especially specific leaf weight (S. L. W.) have been given considerable attention because the ultimate limitation in increasing crop production is the efficiency which a crop absorbs and utilizes solar energy. Traditionally net photosynthesis (Pn) has been expressed on a leaf basis, for the light intercepted by a leaf is a function of its area and its angle to the source of light.

Thorne\(^{(10)}\) compared the net assimilation rates (N. A. R.) of sugar beet, potato and barley at the different plant ages. Her finding was large differences among species when N. A. R. was calculated on leaf area basis. However, the species were quite similar when calculated on a leaf dry weight basis. Therefore, the main differences in N. A. R. among these species were due to their differences in S. L. W.

The average S. L. W. in an alfalfa community decreases as the community grows\(^{(11)}\). Pearce \textit{et al.} \(^{(7)}\) showed that this decrease was primarily due to the shading of lower leaves by upper leaves. When they grew individual alfalfa plants in growth chambers with little mutual shading, they found that S. L. W. increased as the leaves aged. Their study suggested that alfalfa leaves might be to adjust to changing light intensities.

Recent work with alfalfa\(^{(7, 8)}\) has shown that differences in net photosynthesis (Pn) coincided with differences in S. L. W. \((r = .730)\). Differences in S. L. W. and Pn were such that the Pn per unit leaf weight (Pw) remained the same.

Barnes \textit{et al.} \(^{(13)}\) reported significant variation within and among varieties for S. L. W. ranking of alfalfa was not influenced by stage of maturity. S. L. W. and leaf area appeared to be under independent genetic control.

Chatterton \textit{et al.} \(^{(12)}\) suggested the use of diurnal change in S. L. W. as a measure of productivity potential which reflects the photosynthetic production-translocation balance in alfalfa and corn.

The objective of this study was to evaluate the winter active varieties and polycross progenies of 10 genotypes in tall fescue for various plant and leaf characteristics, especially related to photosynthesis and forage production during summer at Daejon, Korea.

\section{Materials and Methods}

\textit{Materials}

Experimental materials for this study was sended by Dr. Rod V. Frakes from Oregon State University, Corvallis, Oregon. The materials included in this study were winter active synthetic variety, Tall Fescue M', and polycross progenies of 10
genotypes selected under the hot and dry weather at Medford, Oregon. The control variety was 'Fawn', a high forage and seed yielding variety developed and released by Oregon State University (Table 1).

Establishment and Maintenance

Seeds on the two sheets of filter paper were prechilled at 5°C in a refrigerator for three days and germinated at 25°C in an incubator from February 24. The healthy seedlings were transplanted in polyethylene pots on March 5 and maintained under a vinylhouse and clipped four times before their transplanting on April 23 in the field. Field plot design was randomized block design with four replications. The spacing was in 90 cm row by 60 cm within row and each entry had nine plants on 60 cm centers per replication.

Weeds were controlled by hand whenever it was necessary. A split application of fertilizer was practiced and the total amount was 4 kg of nitrogen, 1.8 kg of phosphorus, and 3 kg of potassium per 10 are.

Table 1. Identification of the 12 tall fescue varieties and polycross progenies of genotype selected at Southern Oregon State Experiment Station at Medford, Oregon.

<table>
<thead>
<tr>
<th>Group and Entry Number</th>
<th>Varieties and Genotypes</th>
<th>Winter Activity and Other Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control 1</td>
<td>Tall Fescue M (Composite of 10 genotypes)</td>
<td>Winter Active</td>
</tr>
<tr>
<td>Control 2</td>
<td>'Fawn' synthetic variety</td>
<td>High-Yielding</td>
</tr>
<tr>
<td>Control 3</td>
<td>Genotype 16 (Tall Fescue M) polycross Progeny</td>
<td>Winter Active</td>
</tr>
<tr>
<td></td>
<td>&quot; 17 &quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot; 18 &quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot; 19 &quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot; 20 &quot;</td>
<td></td>
</tr>
<tr>
<td>Group 1 8</td>
<td>&quot; 21 &quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot; 22 &quot;</td>
<td></td>
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<tr>
<td></td>
<td>&quot; 24 &quot;</td>
<td></td>
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<tr>
<td></td>
<td>&quot; 26 &quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot; 27 &quot;</td>
<td></td>
</tr>
</tbody>
</table>

Measurements

Leaf Characteristics

Whole leaf above leaf sheath was collected for the measurements of leaf characteristics. Five leaves per plant about the same age were sampled on each plant and the measurements of leaf characteristics were done on the basis of one leaf.

Leaf fresh weight: gm, the weight of the fresh sampled leaf measured on July 27.

Leaf dry weight: gm, the weight of a leaf put on a dry oven at 105°C for six hours
and measured on June 27.

*Leaf area;* cm², the area of a leaf measured by leaf area meter June 27.

*Specific leaf weight;* mg/cm², the ratio of leaf dry weight to unit leaf area on June 27.

*Leaf width;* cm, the widest leaf measured on June 27.

**Plant Characteristics**

The second measurements of plant height, width and tiller number per plant on July 22, were to study the regrowth ability and the effect of defoliation on these plant characteristics made on July 5.

*Plant height;* cm, the tallest part of plant above the ground level measured on June 7 and July 22.

*Plant width;* cm, the widest part of plant above the ground level measured on June 7 and July 22.

*Tiller number;* the number of tillers per plant counted on June 7 and July 22.

*Forage yield;* kg, the fresh cut forage weight per plant measured on July 5 and August 17.

*Total forage yield;* kg, the sum of two previous cuttings of forage per plant.

**Statistical Analysis**

All characteristics were analysed with the analysis of variance procedures and the variance for the entries were partitioned by the function of group in the functional analysis of variance and the general error term was used.

All possible simple correlation coefficients were calculated among all characteristics, except leaf fresh weight, using winter active variety and the performance of genotypes in their polycross progeny.

III. **Results and Discussion**

*Leaf Fresh Weight and Dry Weight*

Leaf fresh weight and dry weight were significantly different among entries, among controls and polycross progeny group and among polycross progenies of genotypes.

The average leaf fresh weight of ‘Fawn’ variety was the heaviest (.43 gm) and those of polycross progeny group (.34 gm) was heavier than those of composite synthetic variety (.30 gm). The average leaf fresh weight among polycross progenies of 10 genotypes ranged from .41 to .22 gm. The leaf dry weight of ‘Fawn’ control was the heaviest (.119 gm) but those of composite synthetic variety (.080 gm) was heavier than those of polycross progeny group (.74 gm). The range of the average leaf dry
weight among polycross progenies of genotypes was from .109 to .062 gm (Table 3).

‘Fawn’ variety had heavier leaf fresh weight and dry weight than the winter active genotypes and variety. Variation in leaf fresh weight and dry weight among polycross progenies of genotypes was great enough to distinguish the difference.

Leaf Area

For leaf area differences among entries and among polycross progeny group and controls and among polycross progenies of genotypes were significant at the five percent level (Table 2).

The average leaf area of ‘Fawn’ was the largest (1.64 cm²) and those of polycross progenies group (1.28 cm²) was larger than those of composite synthetic variety (1.22 cm²). The average leaf fresh weight among polycross progenies of genotypes ranged from 1.64 to .92 cm². (Table 3).

‘Fawn’ variety had larger leaf area than winter active variety and genotypes. Leaf area among polycross progenies of genotypes deviated greatly and polycross progenies of ‘genotype-16’ had the same average leaf area as ‘Fawn’.

Specific Leaf Area (S.L.W.)

Differences of S.L.W. among entries, among polycross progeny group and controls and among polycross progenies of genotypes were not significant (Table 2). Probably the genetic diversity for this characteristic among varieties and genotypes tested in this study were not big enough but were narrowed down already. It was suggested that production of photosynthetate might not different and a study of the photosynthetate production-translocation balance through diurnal change in S.L.W. is necessary.

Leaf Width

Leaf width was significantly different among entries, among polycross progeny group and controls and among polycross progenies of genotypes at the one percent level (Table 2).

The average leaf width of ‘Fawn’ was the widest (.93 cm) and those of polycross progeny group and composite synthetic variety were same (.72). The average leaf width among polycross progenies of genotypes ranged from .62 to .84 cm (Table 3).

‘Fawn’ variety had wider leaf width than the winter active variety and genotypes. Leaf width than the winter active variety and genotypes. Leaf width among polycross progenies of genotypes deviated from the mean.

Plant Height

Plant height measured on June 7. gave significant differences among entries and
among controls and polycross progeny group at the five percent level, but the differences among polycross progenies of genotypes were not significant. However, the plant height measured on July 22, gave significant differences among entries and among polycross progenies of genotypes at the one percent level but the differences among controls and polycross progeny group were not significant (Table 2).

Table 2. Mean squares and levels of significance for seven leaf and plant characteristics of tall fescue (Daejon, Korea. 1975)

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>D.F.</th>
<th>Leaf Fresh Weight</th>
<th>Leaf Dry Weight</th>
<th>Leaf Area June 27</th>
<th>Specific Leaf Weight</th>
<th>Plant Height June 7</th>
<th>Plant Height July 22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replications</td>
<td>3</td>
<td>0.016*</td>
<td>0.00017</td>
<td>0.26*</td>
<td>274.75*</td>
<td>0.0075</td>
<td>74.06**</td>
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<td>Entries</td>
<td>11</td>
<td>0.017**</td>
<td>0.00093**</td>
<td>0.19*</td>
<td>37.23</td>
<td>0.0312**</td>
<td>38.6**</td>
</tr>
<tr>
<td>Among Group and Controls</td>
<td>2</td>
<td>0.020*</td>
<td>0.00190**</td>
<td>0.26*</td>
<td>15.01</td>
<td>0.1195**</td>
<td>76.40**</td>
</tr>
<tr>
<td>Within Group</td>
<td>19</td>
<td>0.018**</td>
<td>0.00090*</td>
<td>0.17*</td>
<td>42.17</td>
<td>0.0180**</td>
<td>30.64</td>
</tr>
<tr>
<td>Error</td>
<td>33</td>
<td>0.004</td>
<td>0.00023</td>
<td>0.07</td>
<td>68.01</td>
<td>0.0043</td>
<td>14.93</td>
</tr>
</tbody>
</table>

* F value exceeds the five percent level of significance.
** F value exceeds the one percent level of significance.

Table 3. Means, grand means, standard errors of mean (sX) and coefficient of variation (C. V.) for seven leaf and plant characteristics of tall fescue (Daejon, Korea. 1975p)

<table>
<thead>
<tr>
<th>Group Number</th>
<th>Entry Number</th>
<th>Leaf Fresh Weight June 27 (gm)</th>
<th>Leaf Dry Weight June 27</th>
<th>Leaf Area June 27 (cm²)</th>
<th>Specific Leaf Weight July 27 (mg/cm²)</th>
<th>Leaf Width July 22 (cm)</th>
<th>Plant Height June 7 (cm)</th>
<th>Plant Height July 22 (cm)</th>
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</thead>
<tbody>
<tr>
<td>Control</td>
<td>1</td>
<td>.30</td>
<td>.080</td>
<td>1.22</td>
<td>66.6</td>
<td>.72</td>
<td>34.4</td>
<td>43.0</td>
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<tr>
<td>Control</td>
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<td>.43</td>
<td>.119</td>
<td>1.64</td>
<td>69.1</td>
<td>.98</td>
<td>40.5</td>
<td>49.1</td>
</tr>
<tr>
<td>3</td>
<td>.39</td>
<td>.109</td>
<td>1.64</td>
<td>67.5</td>
<td>.70</td>
<td>34.2</td>
<td>46.2</td>
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<td>4</td>
<td>.22</td>
<td>.602</td>
<td>.92</td>
<td>66.3</td>
<td>.62</td>
<td>29.3</td>
<td>37.1</td>
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<tr>
<td>5</td>
<td>.35</td>
<td>.096</td>
<td>1.32</td>
<td>71.9</td>
<td>.78</td>
<td>35.9</td>
<td>43.1</td>
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<tr>
<td>6</td>
<td>.33</td>
<td>.087</td>
<td>1.34</td>
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<td>.70</td>
<td>30.4</td>
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<tr>
<td>Group 1</td>
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<td>.41</td>
<td>.096</td>
<td>1.50</td>
<td>54.7</td>
<td>.84</td>
<td>33.5</td>
<td>49.6</td>
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<tr>
<td>8</td>
<td>.29</td>
<td>.078</td>
<td>1.11</td>
<td>69.5</td>
<td>.71</td>
<td>34.6</td>
<td>44.3</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>.32</td>
<td>.089</td>
<td>1.13</td>
<td>74.3</td>
<td>.66</td>
<td>33.0</td>
<td>42.8</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>.38</td>
<td>.092</td>
<td>1.28</td>
<td>71.6</td>
<td>.68</td>
<td>32.2</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>.38</td>
<td>.099</td>
<td>1.38</td>
<td>72.5</td>
<td>.81</td>
<td>36.0</td>
<td>50.8</td>
<td></td>
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<tr>
<td>2</td>
<td>.28</td>
<td>.078</td>
<td>1.20</td>
<td>65.3</td>
<td>.74</td>
<td>40.1</td>
<td>41.8</td>
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<tr>
<td>X</td>
<td></td>
<td>.34</td>
<td>.074</td>
<td>1.28</td>
<td>69.5</td>
<td>.72</td>
<td>33.9</td>
<td>44.5</td>
</tr>
<tr>
<td>Grand mean</td>
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<td>.34</td>
<td>.090</td>
<td>1.31</td>
<td>69.2</td>
<td>.74</td>
<td>34.5</td>
<td>44.8</td>
</tr>
<tr>
<td>sX</td>
<td></td>
<td>.03</td>
<td>.008</td>
<td>13</td>
<td>4.12</td>
<td>.03</td>
<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td>C. V.</td>
<td></td>
<td>18.60%</td>
<td>16.85%</td>
<td>19.76%</td>
<td>11.92%</td>
<td>8.86%</td>
<td>11.20%</td>
<td>8.52%</td>
</tr>
</tbody>
</table>
On the first measurement the average plant height of 'Fawn' was the tallest (40.5 cm) and those of composite synthetic variety and the polycross progeny group were 34.4 and 33.9 cm respectively. Differences among polycross progenies on the second measurement which reflected the regrowth, ranged from 37.1 to 50.8 cm (Table 3).

These results indicated that differences among controls and polycross progeny group in the initial plant height were apparent and variety 'Fawn' was taller than winter active genotypes and variety under test, but the differences among those were not like such in the regrowth of plant height for 15 days after the first forage harvest on July 7. On the contrary, differences among polycross progenies were not apparent in the initial measurement of plant height, but the differences among those genotypes in the performance of their progenies became obvious in the regrowth and variation in this characteristic among polycross progenies of genotypes was great. The regrowth ability is an important agronomic characteristics for forage crops which is harvested manytimes throughout the growing period in the pasture and for hay and silage.

Plant Width

Differences of plant width on both measurements, on June 7 and June 22, were significant among control and polycross progeny group at the five and one percent level respectively (Table 4).

On the first measurement, the average plant width of composite synthetic variety gave the largest (12.5 cm) and those of variety 'Fawn' and the polycross progeny group were 12.1 and 11.3 cm. On the other hand, the average plant width of 'Fawn' variety on the second measurement were the largest and those of composite synthetic variety and the polycross progeny group were 11.9 and 12.8 cm respectively (Table 5).

This indicated that plant width of 'Fawn' was greater than those of winter active genotypes and variety after the first cutting.

Tiller Number

Measurement of tiller number per plant on June 7, did not show significant differences. From the second measurement of this characteristic differences of tiller number among entries and among controls and polycross progeny group and among polycross progenies of genotypes were significant (Table 4).

On the second measurement, the average tiller number per plant of 'Fawn' variety was the largest (122) and those composite synthetic variety and the polycross progeny group were 87 and 99. Those of polycross progenies of genotypes ranged from 87 to 121 (Table 5).

This indicated that differences of tiller number became evident and 'Fawn' had higher tiller number after the first forage cutting. There were considerable deviations in the tiller number among polycross progenies of the genotypes on the second measur-
rement. It was obvious that the genetic differences became more evident in the second measurement probably because this characteristic were stimulated by defoliation in the certain genotypes and variety.

**Forage Yield**

Differences of forage yield per plant among entries, among controls and polycross progeny group and among polycross progenies of genotypes were significant on the first and second harvest and total yield, the sum of both harvestings of forage (Table 4).

Table 4. Mean squares and levels of significance for seven plant characteristics and forage yield of tall fescue (Daejon, Korea 1975)

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>D.F.</th>
<th>Plant Width June 7</th>
<th>Plant Width July 22</th>
<th>Tiller Number June 7</th>
<th>Tiller Number July 22</th>
<th>Forage Yield July 5</th>
<th>Forage Yield Aug. 17</th>
<th>Total Forage Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replications</td>
<td>3</td>
<td>4.83**</td>
<td>2.1</td>
<td>121.1</td>
<td>92.1</td>
<td>.71**</td>
<td>.77**</td>
<td>2.62**</td>
</tr>
<tr>
<td>Entries</td>
<td>11</td>
<td>1.89</td>
<td>5.7**</td>
<td>146.4</td>
<td>31.8**</td>
<td>.62**</td>
<td>.74**</td>
<td>2.13**</td>
</tr>
<tr>
<td>Among Group and Controls</td>
<td>2</td>
<td>5.01**</td>
<td>21.0**</td>
<td>267.3</td>
<td>1340.7**</td>
<td>1.55**</td>
<td>2.61**</td>
<td>8.55**</td>
</tr>
<tr>
<td>Within Group 19</td>
<td>19</td>
<td>1.19</td>
<td>2.3</td>
<td>119.6</td>
<td>474.4*</td>
<td>.14*</td>
<td>.81**</td>
<td>.70*</td>
</tr>
<tr>
<td>Error</td>
<td>33</td>
<td>1.47</td>
<td>1.5</td>
<td>142.8</td>
<td>199.4</td>
<td>.15</td>
<td>.10</td>
<td>.24</td>
</tr>
</tbody>
</table>

* F value exceeds the five percent level of significance.
** F value exceeds the one percent level of significance.

Table 5. Means, grand means, standard errors of mean (sX) and coefficient of variation (C.V.) for seven plant characteristics and forage of tall fescue (Daejon, Korea 1975)

<table>
<thead>
<tr>
<th>Group Number</th>
<th>Entry Number</th>
<th>Plant Width June 7 (cm)</th>
<th>Plant Width July 22 (cm)</th>
<th>Tiller Number June 7</th>
<th>Tiller Number July 22</th>
<th>Forage Yield July 5 (Kg)</th>
<th>Forage Yield Aug. 17 (Kg)</th>
<th>Total Forage Yield (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1</td>
<td>12.5</td>
<td>11.9</td>
<td>94</td>
<td>87</td>
<td>1.48</td>
<td>1.10</td>
<td>2.58</td>
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<tr>
<td>Control</td>
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<td>2.60</td>
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<td></td>
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<td>11.5</td>
<td>12.4</td>
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<td>97</td>
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<td></td>
<td>4</td>
<td>10.9</td>
<td>12.1</td>
<td>92</td>
<td>87</td>
<td>1.22</td>
<td>.84</td>
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<td>11.7</td>
<td>14.3</td>
<td>84</td>
<td>121</td>
<td>1.67</td>
<td>1.55</td>
<td>3.21</td>
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<tr>
<td></td>
<td>6</td>
<td>11.0</td>
<td>12.6</td>
<td>96</td>
<td>113</td>
<td>1.54</td>
<td>1.32</td>
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<td>Group I</td>
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<td>10.4</td>
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<td></td>
<td>8</td>
<td>12.1</td>
<td>12.6</td>
<td>91</td>
<td>95</td>
<td>1.66</td>
<td>1.18</td>
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<tr>
<td></td>
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<td>11.7</td>
<td>94</td>
<td>89</td>
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<td>10.9</td>
<td>12.7</td>
<td>89</td>
<td>103</td>
<td>1.63</td>
<td>1.15</td>
<td>2.78</td>
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<td></td>
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<td>12.2</td>
<td>13.4</td>
<td>93</td>
<td>89</td>
<td>2.28</td>
<td>1.23</td>
<td>3.51</td>
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<tr>
<td></td>
<td>X</td>
<td>11.3</td>
<td>12.8</td>
<td>90</td>
<td>99</td>
<td>1.74</td>
<td>1.30</td>
<td>2.59</td>
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<tr>
<td>Grand mean</td>
<td></td>
<td>11.4</td>
<td>13.0</td>
<td>89</td>
<td>100</td>
<td>1.79</td>
<td>1.36</td>
<td>3.10</td>
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<tr>
<td>sX</td>
<td></td>
<td>.61</td>
<td>.60</td>
<td>5.97</td>
<td>7.06</td>
<td>.19</td>
<td>.16</td>
<td>.24</td>
</tr>
<tr>
<td>C.V.</td>
<td></td>
<td>10.63%</td>
<td>9.36%</td>
<td>14.12%</td>
<td>21.27%</td>
<td>23.25%</td>
<td>15.80%</td>
<td></td>
</tr>
</tbody>
</table>
On the both measurements and total forage yield 'Fawn' variety was the highest forage yielder (2.60, 2.46 and 2.05 kg) and those of the polycross progeny group (1.74, 1.30 and 2.96 kg) were higher than those of composite synthetic variety (1.48, 1.10 and 2.58 kg). The dispersion of average forage yield among polycross progenies of genotypes were great 1.22–2.23 kg, .84–1.65 kg and 2.06–3.51 kg (Table 5).

These results indicated that forage yield of 'Fawn' was higher than those of winter active genotypes and variety on the initial growth, the regrowth ability and total yield. Deviation of forage yield among polycross progenies of genotypes were great and gave a basis for selection according to their progeny performance.

**Associations Among Leaf and Plant Characteristics**

**Among Leaf Characteristics**

Significant simple correlation coefficient among leaf characteristics was only between leaf dry weight and area (r=.9086**) in Fig. 1.

It became apparent that the ratio of leaf dry weight to unit of leaf area, that is, specific leaf area (S. L. W.) did not show any significant differences among and within group and controls in Table 2, because of this close relation between two component characteristic. These consequences suggested that probably some kind of genetic relations like a tight linkage relation between these two characteristics might be presented in this population tested. A further investigations for possible linkage relationship was suggested for the future.

If S. L. W. is coincided with net assimilation rate (N. A. R.) in this population of tall fescue like in alfalfa study(13), then N. A. R. among and within these genotypes and varieties might not be different. Then we might need to study diurnal changes in S. L. W. than S. L. W. at a fixed time of day.

**Among Leaf and Plant characteristics**

Significant simple correlation coefficients among leaf characteristics were; (Fig. 2).

Fig. 1. Association between leaf dry weight and leaf area.

Fig. 2. Association between leaf dry weight and plant height on July 22.
between leaf dry weight and plant height on the second measurement \( (r = .7461**) \); (Fig. 3), between leaf area and plant height on the second measurement \( (r = .7664**) \); (Fig. 4), between leaf width and plant height on the second measurement \( (r = .7699**) \); (Fig. 5), between leaf width and plant width on the second measurement \( (r = .7350**) \); and (Fig. 6), in a negative value between leaf width and tiller number on the first measurement \( (r = -.7225**) \).

**Fig. 3.** Association between leaf area and plant height July 22.  
**Fig. 4.** Association between leaf width and plant height on July 22.  
**Fig. 5.** Association between leaf width and plant width on July 22.  
**Fig. 6.** Association between leaf width and tiller number on June 7.

*Among Leaf Characteristics and Forage Yield Measurements*

Significant simple correlation coefficients among leaf characteristics and forage yield measurements were: (Fig. 7), between leaf dry weight and forage yield \( (r = .6989) \); (Fig. 8), between leaf area and total forage yield \( (r = .6950*) \); and (Fig. 9), between leaf width and forage yield on the second measurement \( (r = .9354**) \).
Among Plant Characteristics

Significant simple correlation coefficient among plant characteristics were; (Fig. 10), in a negative value between plant width on the second measurement and tiller number on the first measurement ($r = -0.6446^*$); and (Fig. 11), between plant width and tiller number, both on the second measurement ($r = 0.6528^{**}$).

![Fig. 7. Association between leaf dry weight and total forage yield.](image)

![Fig. 8. Association between leaf area and total forage yield.](image)

![Fig. 9. Association between leaf width and forage yield on August 17.](image)

![Fig. 10. Association between plant width on July 22 and tiller number on June 7.](image)
Among Plant Characteristics and Forage Yield Measurements

Significant simple correlation coefficients among plant characteristics and forage yield were: (Fig. 12), between plant height and forage yield, both on the first measurement ($r = 0.6871^{**}$); (Fig. 13), between plant height and forage, both on the second measurement ($r = 0.8187^{**}$); (Fig. 14), between plant height on the first measurement and total forage yield ($r = 0.7205^{**}$); (Fig. 15), between plant width and forage yield, both on the second measurement ($r = 0.7844^{**}$); (Fig. 16), in a negative value between tiller number and the first measurement and forage yield on the second measurement ($r = -0.7254^{**}$); and (Fig. 17), between tiller number and forage yield, both on the second measurement ($r = 0.6142^{**}$).

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Fig. 11. Association between plant width and tiller number on July 22.

Fig. 12. Association between plant height on June 7 and forage yield on July 5.

Fig. 13. Association between plant height on July 22 and forage yield on August 17.

Fig. 14. Association between plant height on June 7 and total forage yield.
Among Forage Yield Measurements

Significant correlation coefficients among forage yield measurements were: (Fig. 18), between the first and total forage yield measurements ($r = .7812^{**}$); and (Fig. 19), between the second and total forage yield ($r = .6037^{**}$).

The results of the association among various characteristics under study were quite agreeable with the results of the analysis of variance and would be useful in the selection of desirable genotypes for the development of a new variety.
Fig. 19. Association between forage yield on August 17 and total forage yield.

VI. Summary

This study was conducted to evaluate the winter active polycross progenies of 10 genotypes selected at the hot and dry climate of the Southern Oregon in their performance in the progeny test comparing with a high yielding variety, 'Fawn', and a winter active variety, 'TFM', as the control varieties at Daejon, Korea. Various plant and leaf characteristics, especially which related to photosynthesis, and forage production during the first summer after their establishment, were examined.

The important conclusions of this study are summarized as follows:

1. The winter active genotypes and variety had less leaf fresh weight and dry weight per leaf than variety 'Fawn'. Variations among polycross progenies of genotypes for these characteristics were great.

2. The winter active genotypes and variety had less leaf area per leaf than variety 'Fawn'. Leaf area among polycross progenies of genotypes deviated greatly and polycross progenies of 'genotype-16' had the same average leaf area as 'Fawn'.

3. Differences of specific leaf weight (S.L.W.) in the winter active genotypes and variety were not significant. Probably the genetic diversity for S.L.W were not big and were narrowed down already in this genetic population. It was suggested that the photosynthate production within the population might not be different and there might be differences in the photosynthate production-translocation balance. Further study for the diurnal change in S.L.W. within the population might be useful.

4. The winter active variety and genotypes had less leaf width than 'Fawn' does. Leaf width among polycross progenies of genotypes deviated significantly.
5. Differences among controls and polycross progeny group in the initial plant height were significant and variety 'Fawn' was taller than the winter active genotypes and variety. But the differences were not significant in the regrowth of plant height after the first forage harvest. On the contrary, the differences among polycross progenies of genotypes were not significant in the initial plant but the differences in their polycross progeny performance became obvious and great in the regrowth ability which is an important agronomic characteristics for forage crops produced in the pasture and for hay and silage.

6. Plant width of the winter active genotypes and variety was lesser than 'Fawn' variety.

7. Differences of tiller number became evident and variety 'Fawn' had higher tiller number than the winter active genotypes and variety after the first forage cutting. There, deviations among polycross progenies of genotypes were great for this characteristic. It was obvious that the genetic differences became more evident in the second measurement after the first cutting of forage probably because this characteristic were stimulated by defoliation in the certain genotypes and variety.

8. The winter active genotypes and variety on the initial growth, the regrowth ability and total yield had lesser forage yield than variety 'Fawn'. Deviation of forage yield among polycross progenies of genotypes were great and gave basis for selection according to their polycross progeny performance improving the forage yield of these winter active tall fescue population during summer.

9. It was concluded that the winter active variety and genotypes in this study was poorer than variety 'Fawn' for the most of leaf and plant characteristics including forage yield. For these measurements, the variations among polycross progenies of genotypes were great, and plant breeding might able to improve further this winter active tall fescue through the polycross progeny testing method for the higher forage production during summer in Korea.

10. The result of the associations among various characteristics under study were quite agreeable with the results of the analysis of variance and would be useful in the selection of desirable genotypes for the development of a new variety.

Literature Cited


본 연구는 남부 Oregon의 고온건조한 기후에서 성장된 Tall fescue 10개의 인자형의 동시 생육형과 대개가락 후대의 능력을 결정하기 위하여 하루재 종합대학 농과대학 식량포장에서 수행되었는데 이들 과체료품들은 대한 대비 품종으로는 다수품종인 Fawn과 동시 생육형 품종 T.F.M을 공시하였으며 특히 광활성과 관련이 깊은 식물체 및 잔의 주요 결합과 아울러 계획 후 1차 여름의 조적성 산탄을 조사 분석하였다. 주요한 결과는 다음과 같다.

1) 단위일당 생체장 및 전물증을 다수품 Fawn과 비교 동시 생육형 과체료품 및 품종이 현저히 가 빠졌으며 계획 이들 역형집에 있어서는 과체료품간에도 아주 큰 변화를 나타내고 있었다.

2) 단위일당적 영양적 차이를 나타내는 다수품 Fawn과 비교 동시 생육형 과체료품 및 품종에서 적었다. 다개가락 과체료품간에는 상당한 역형적 차이를 보였는데 인자형 16의 다개가락 과체료품의 경우 영양적 영향력은 Fawn의 영향력과 차이가 있었다.

3) 동시 생육형 과체료품 및 품종간에는 특정점증(단위일당 적)의 차이가 인정되지 않았던 바 특성점 증의 유전적인 차이는 대체로 크지 않았으며 이 특성점간에서는 이마 증가된 것으로 추측된다. 한편 압력 내에서 광활성 생산은 차이가 없을 것이나 광활성생산간 전류간의 동형에서는 차이가 있을 것으로 추측되는 바 이리한 문제를 고려하기 위해서는 특정 영중의 주간 변화에 관한 연구가 이루어져야 할 것이다.

4) 영양은 Fawn과 비교 동시 생육형 품종 및 과체료품에서 줄었으며 다개가락 과체료품에는 인자 한 영역의 변화를 나타내었다.

5) 제1회 역형점의 초장은 대비품종과 동시생육형 품종 및 다개가락 과체료품간에 현저한 차이를 보으던 바 다수품 종 Fawn의 초장이 현저히 길었으나 입차 역형의 초장의 재생력이 있어서는 유의차가 인 정되지 않았다. 한편 다개가락 과체료품간에서는 제1회 초장간 유의차가 인정되지 않았으나 묵어거나 사 일터치 생산에 관련되는 중요한 역형의 하나인 재생력에 있어서는 다개가락 과체료품을 전체 명확하고도 인 지한 차이를 나타내었다.

6) 사물말 혹은 다수품종 Fawn와 비교 동시 생육형에서 현저히 줄었다.

7) 분량수의 차이 역시 현저하였던 바 대비 품종 Fawn에서 동시 생육형 과체료품이나 품종보단 현저히 입 차 역형의 분량수가 증가 되었다. 특히 분량수에 있어서는 다개가락 과체료품간 측면을 보였던바 입 차 역형의 이차 측정에서 대체로 유전적인 차이가 더욱 두_thickness이 명확하였는데 이는 어떤 품종이나 인 자형들에서는 낙엽에 의해서 이 현상이 아마 측정이 되었기 때문이 아닌가 생각된다.

8) 동시 생육형 과체료품 및 품종간 초기 생육 재생력 및 충수량은 대비 품종 Fawn과 비교 현저히 낮 은 경향을 보였다. 한편 과체료품간 생성초량의 변이가 큰 경향을 보였는데 이러한 점은 동시 생육형 Tall Fescue 모질단의 수량을 작용시키는 다개가락 과체료품의 선박을 여름에 수행하는 기초를 제공하고 있다.

9) 본 연구에 공시된 동시 생육형 품종 및 과체료품 간의 체장 수량을 위한 계획적인 일부 사물체의 형질 은 대비품종 Fawn의 비교 우수하지 못하였으나 이로 형질의 다개가락 과체료품간의 변이가 아주 적었던 바 한 계단에서는 여름품종의 다수품에 관한 다개가락 차데점증을 통하여 동시 생육형 Tall Fescue의 계량이 가능할 것으로 본다.

10) 본 연구에 있어서 여름형성간의 이상관계의 결과는 분산분석의 결과와도 잘 일치하고 있는바 진품 증개발을 위한 바람직한 인자형의 발달에 기여하는 바가 큰 것으로 사료된다.