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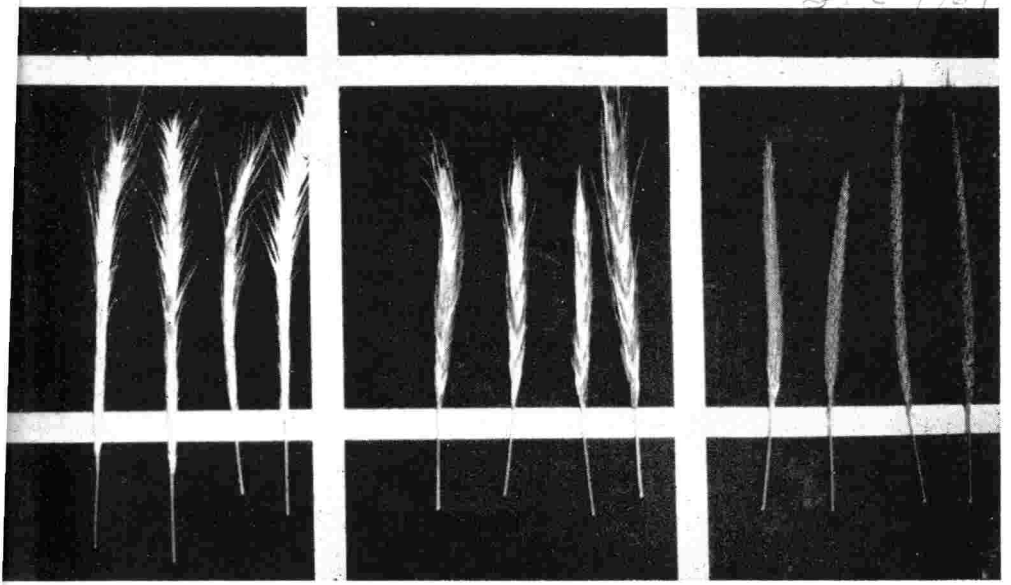

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SMALL grains are widely used for pasture, hay, and grain in Tennessee. These crops produce needed forage during the fall, winter, and early spring, and later, a hay or grain crop. A second crop, such as soybeans for hay or beans or corn for silage, can be planted after small grains are harvested for hay or, with careful management, after grain production. Small grains used for pasture produce economical and desirable forage. Experiments in Georgia have shown (4, 5) that beef gains of 2.22 to 2.62 pounds per day were cheaper on oats and rye pastures than gains from dry lot feeding.

Good management practices for small grains for hay and grain production were established through research and observation and have been recognized for many years. Recent changes in varieties and cropping practices have made it necessary to re-evaluate production methods such as time of planting, seeding rate, and fertilization practices. Also, little is known concerning the relative production of barley, wheat, oats, and rye for forage. Early fall planting is necessary for good forage yields. This was recognized by Washko (7) and Graves (1). Graves (1) showed that about September 15 was the best time to plant wheat for fall pasture. Little or no fall forage was produced from wheat planted October 15. Good forage yields were obtained from plantings made August 15, but because of leaf rust damage and difficulty in establishing stands in some years, this planting date was not satisfactory. Washko (7) compared the forage production of varieties of barley, wheat, oats, and rye by fall and spring grazing with sheep. Rye produced the greatest total season yield. Wheat produced significantly less forage than the other crops in the fall while oats had the lowest yield in the spring.

Since early planting is necessary for good fall forage production for all small grain crops, a 2-year study of the relative production of barley, oats, rye, and wheat was made with plantings made between September 1 and September 15. Varieties that are currently available or were recently important were used in this study.

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EXPERIMENTAL METHODS

Two varieties each of barley (Kenbar and Dayton) and wheat (Monon and Knox 62), three of oats (Blount, LeConte, and Forkedeer), and one of rye (Balbo) were evaluated for 2 years at four locations. Forage was harvested when the plants were 8 to 10 inches tall from the center row of 3-row plots 16 or 24 feet long with rows 12 inches apart. To simulate grazing, the plants were cut to a 2-inch height. Six replications were used in each experiment. Seeding rates recommended for grain production were used: 2 bushels for barley and oats and 1½ bushels per acre for wheat and rye. In each experiment, all varieties were harvested on the same day with exceptions as noted in Table 1. The planting and harvest dates varied during the 2 years and are included in Tables 1 and 2. Grain yields were determined at Springfield after fall and spring forage harvest and from six replications where no forage was harvested. Fertilization at planting time consisted of 36 pounds of N, 72 pounds of P_2O_5 and 72 pounds of K_2O per acre applied as 600 pounds per acre of 6-12-12.

FALL FORAGE PRODUCTION

Fall forage yields from six experiments are given in Table 1 and the mean yields for five experiments are given graphically in Figure 1. There was considerable variation between years and locations, but the oat varieties generally produced less forage than the barley, wheat, or rye varieties. Since all varieties were harvested at the same time, this indicates that the early fall growth rate of oats was slower than the growth of other small grains. This is also shown by the 1965-66 data from Jackson where oat yields were similar to the other crops but harvest was delayed 12 days. Blount oats, with its erect fall growth, produced significantly more forage than LeConte or Forkedeer oats and was not significantly different from Monon and Knox 62 wheat. The wheat, barley, and rye varieties produced approximately equal amounts of fall forage. Monon and Knox 62, both Hessian fly resistant varieties, competed favorably with the other small grains in contrast to the earlier results of Washko (2).

SPRING AND TOTAL SEASON FORAGE PRODUCTION

Forage was harvested in mid to late March (Table 2) at Jackson and Springfield. Balbo rye had the highest forage yield at this time but not significantly more than Monon wheat (Table 2 and Figure 1). As with fall forage production, the oat varieties were

Table 1. Fall forage production (pounds of dry matter per acre) of 8 small grain varieties at four locations in 1964 and 1965

Crop and variety	Jackson		Crossville	Springfield	Knoxville	
	1964-65	1965-66	1965-66	1965-66	1964-65	1965-66
	Pounds of dry matter per acre					
Wheat						
Monon	1422	1198	985	853	242	699
Knox 62	1612	1261	1021	889	230	631
Rye						
Balbo	1364	1425	1094	1021	512	558
Barley						
Dayton	1368	1016	1030	799	359	926
Kenbar	1723	1284	1320	1234	351	894
Oats						
Blount	1066	1429	962	1053	379	422
LeConte	298	1348	422	858	141	227
Forkedeer	167	1361	182	576	109	250
L.S.D. (.05)	341	207	235	267	128	325
Date planted	9/9/64	9/1/65	8/30/65	8/31/65	9/17/64	9/ 7/65
Date harvested	11/5/64	*	10/18/65	10/27/65	11/12/64	10/28/65
No. days from planting to harvest	57	*	49	58	56	51

*Wheat and barley, 45 days; rye, 48 days; oats, 57 days.

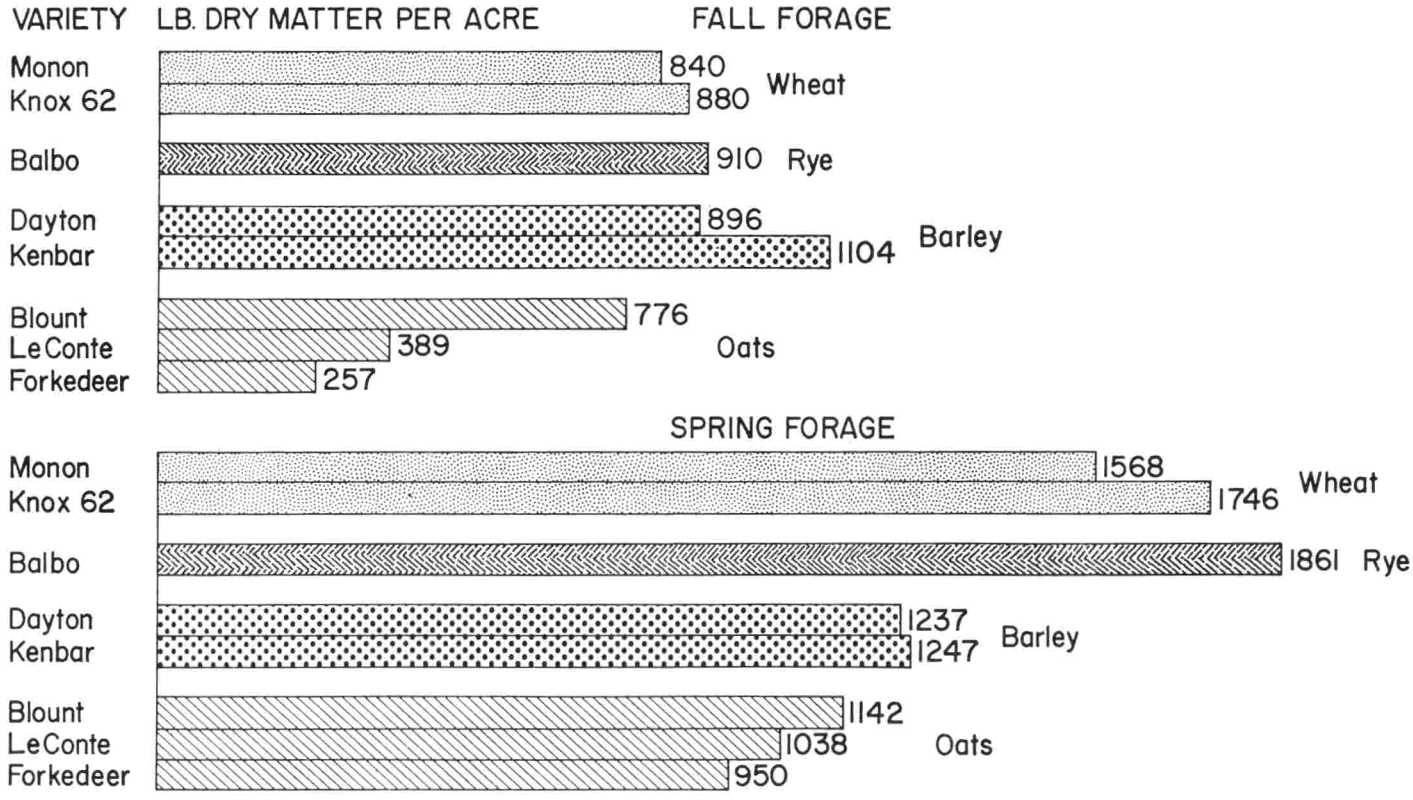

Figure 1. Fall and spring forage production (pounds of dry matter per acre) of eight small grain varieties; L.S.D. (.05) 96 pounds per acre for fall forage, 207 pounds for spring forage. Mean yields from 5 and 3 experiments for fall and spring, respectively.

Table 2. Spring and total season forage production (pounds of dry matter per acre) of 8 small grain varieties at two locations in 1965 and 1966

Crop and variety	Spring			Total Season (fall & spring)			
	Jackson		Springfield	Jackson		Springfield	
	1964-65	1965-66	1965-66	1964-65	1965-66	1965-66	Mean
	Pounds of dry matter per acre						
Wheat							
Monon	2077	1779	849	3499	2977	1702	2726
Knox 62	2330	1888	1021	3942	3149	1910	3000
Rye							
Balbo	2065	2074	1443	3429	3499	2464	3131
Barley							
Dayton	1103	1797	812	2471	2813	1611	2298
Kenbar	1318	1602	821	3041	2886	2055	2661
Oats							
Blount	1021	1298	1107	2087	2727	2160	2325
LeConte	705	1261	1148	1003	2609	2006	1873
Forkedeer	676	1207	967	843	2568	1543	1651
L.S.D. (.05)	237	498	315	188	264	203	127
Date harvested	3/11/65	3/21/66	3/24/66				

less productive than the other crops. However, in contrast to the fall production, the barley varieties produced significantly less forage than did the wheat and rye varieties.

Total season production (Table 2) for two locations indicated the same ranking of crops as for the spring forage yields. The oat varieties were significantly lower in total season forage yield.

GRAIN PRODUCTION AFTER FORAGE HARVEST

It is well known that grain yields can be lowered by spring grazing. The amount of yield reduction depends on the time of livestock removal. This is because the young spikes or panicles may be removed by livestock after the culms begin to elongate. Additional tillering is not extensive after culm elongation so new heads are not formed; thus grain yield is lowered.

A standard date for livestock removal cannot be established for minimum grain yield reductions because temperature, soil fertility, and variety affect the rate of growth. Rapid growth of small grains occurs when temperatures are above 40°F (3), so periodic inspection of the position of the head primordia is necessary to determine the cutoff date for grazing. Grazing should be discontinued before the head primordia are high enough (1 to 2 inches) to be eaten by livestock.

Grain yields were determined at Springfield in the experiments reported above and also from plots where forage had not been harvested previously. In 1965 when the yields were moderately good for barley, wheat, and rye, the greatest reduction in grain yield was obtained for wheat and rye (Table 3) and only a slight reduction was found for barley. In 1966 the grain yields were very low even on plots where no forage was harvested and the grain yield reduction due to forage harvest was greater than 50% for all varieties. These reductions in grain yield were similar to those reported by Graves (1) and Washko (7). The variation in grain yield reduction between locations and varieties further emphasizes the importance of examination of the position of the head primordia so that grazing can be discontinued in time to allow maximum grain production. The usual spring fertilization with nitrogen after grazing is recommended for maximum grain production.

SPRING FREEZE DAMAGE

Spring freezes after the grain has headed can result in grain yield reduction by causing sterility in the heads. Varieties that head early — such as Monon and Knox 62 wheat and most barley

Table 3. Comparison of grain production (bushels per acre) of 8 small grain varieties with and without previous forage harvest at Springfield

Crop and variety	1964-1965			1965-1966		
	No forage harvest	Forage harvested 3/31	Reduction due to forage harvest	No forage harvest	Forage harvested 3/24	Reduction due to forage harvest
	Bu.	Bu.	%	Bu.	Bu.	%
Wheat						
Monon	40.5	26.8	34	16.3	7.6	53
Knox 62	33.2	26.7	20	17.3	6.9	60
Rye						
Balbo	31.4	21.6	31	18.2	6.6	64
Barley						
Dayton	54.7	52.9	3	26.0	8.2	68
Kenbar	58.4	53.0	9	28.8	7.6	74
Oats						
Blount	—	—	—	56.3	25.3	55
LeConte	—	—	—	64.1	23.8	63
Forkedeer	—	—	—	58.4	28.1	52

Table 4. Sterile or partially sterile heads due to spring freezing at flowering time at Knoxville in 1966

Crop and variety	Percent damaged heads	
	No forage harvest	Forage harvested in October
	%	%
Wheat		
Monon	41	34
Knox 62	57	23
Barley		
Dayton	23	26
Kenbar	33	10
Oats		
LeConte	6	7
Blount	6	3
Forkedeer	24	11
Rye		
Balbo	15	5
Mean	26	15

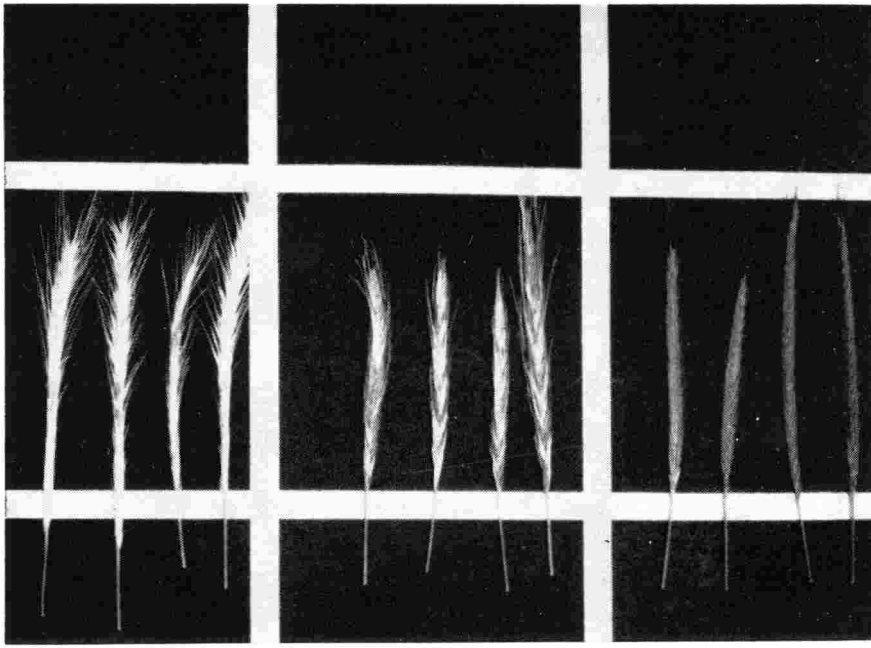

Figure 2. Degrees of freeze damage: complete sterility (left); partial sterility (center); and no sterility (right), in Balbo rye.

and rye varieties — are quite susceptible to freeze damage. Fall and winter grazing will delay heading a few days and sometimes lessen the damage from freezing. This occurred in 1966 at Knoxville and visual estimates of head damage were obtained (Table 4). An example of freezing damage to heads of Balbo rye is shown in Figure 2. Where no fall forage was harvested the wheat and barley varieties and Forkedeer oats were damaged considerably. The amount of damage was 42% less for all varieties on plots where forage had been removed.

Susceptibility to spring freeze damage is also related to the time of planting in the fall. Early planting (September 1-15) usually results in a large amount of leaf growth in the fall and winter. During a period of warm days in the early spring, the culms elongate rapidly and the small head primordia are very susceptible to freezing. If a freeze follows the warm period, sterility of individual florets occurs or the entire head is damaged and fails to develop. Therefore, when fall growing conditions are such that excessive growth occurs, grazing may delay maturity sufficiently to lower grain yield losses due to spring freezing.

DISEASES

Diseases were not important in the experiments reported here, but with early fall planting several diseases can cause serious damage to small grains and some comments are in order here. The **barley yellow dwarf virus** disease (BYDV) is transmitted by several aphid species (for example, the apple-grain aphid), and all small grains are damaged by this disease. BYDV is also found on most forage and volunteer grasses so aphid flights from these grasses to the young grain seedlings can spread the disease, especially in the early fall when aphid flights are most extensive. This disease is characterized by yellowing (or reddening in oats and some wheat varieties) of the leaves and dwarfing. The dwarfing is most noticeable in the spring. Sterility in the heads or failure to head is common. Resistant varieties provide the only practical control of BYDV, although some control from late planting has been observed. Insecticide sprays for aphid control are occasionally beneficial, but normally the virus is transmitted from the aphid to the plant very rapidly so that chemical control is too late to prevent infection by BYDV. In general, the order of increasing susceptibility of the small grain crops is as follows: rye, wheat, barley, and oats. Resistant varieties are not currently available, although Blount oats was found to be considerably more tolerant than Forkedeer (6). For early planting, wheat or rye may have less damage from BYDV than oats or barley.

Leaf rust of wheat, barley, and rye and **crown rust** of oats (which attacks the leaves) can become severe from very early planting (as in August) but usually are not important in September-October plantings. Resistant varieties provide the best control. Several new wheat varieties are resistant to leaf rust, but Monon and, to a lesser extent, Knox 62, are susceptible in Tennessee. Kenbar and Dayton barley are susceptible to leaf rust, and Blount, Forkedeer, and LeConte oats are susceptible to crown rust. Crown rust of oats is usually not very important in Tennessee in the spring because most varieties mature early enough to escape serious damage.

Barley and wheat are susceptible to **powdery mildew**, and oats, although susceptible, is only rarely infected. With excessive fall growth, powdery mildew can become severe, especially during the cool temperatures of early spring. Resistant varieties of barley and wheat are available and the most recent variety test bulletin should be consulted for disease reactions (2).

Other leaf diseases which can infect barley in the fall are **net**

blotch, spot blotch, and **scald.** Of these, net blotch and scald are most important. Resistant varieties provide control, although Dayton and Kenbar are susceptible. **Septoria leaf blotch** can infect wheat varieties in the fall but not usually to the extent that forage yields are affected. **Septoria glume blotch** infects the leaves and the heads so it is an important disease in the spring. The Septoria diseases are important in Tennessee and at present no resistant varieties are available.

In general, small grains for winter grazing should be planted in September which may result in damage from leaf diseases and BYDV, but the risk is less than when planting is done in August. Later planting can reduce both fall and spring damage from BYDV. Since wheat and rye are less susceptible to BYDV than barley, and especially oats, it may be advantageous to use wheat or rye for pasture. Disease reactions for several diseases are given for the currently available varieties in the most recent variety test bulletin (2).

SUMMARY AND CONCLUSIONS

THE relative fall and spring forage production of barley, oats, rye, and wheat varieties was determined in simulated grazing experiments for plantings made September 1-15. The results showed that the growth rate of oats was generally slower than that of the other grains. Blount oats was considerably more productive than Forkedeer and LeConte, and its fall growth was not greatly different from the barley, wheat, and rye varieties. Similar relationships were found in the spring except that barley, in addition to oats, was less productive than wheat or rye. Grain yield reductions when forage was harvested between March 11 and March 31 were quite variable and indicated that the position of the developing heads must be carefully checked during spring grazing if grain production is desired. Fall and spring grazing can delay heading such that grain yield reduction due to spring freezes is minimized. Grazing is an important management factor for grains planted early in the fall.

Wheat seemed more desirable for grazing than the other crops if grain yield is desired, because 1) hessian fly resistant varieties can be planted early; 2) rapid fall and winter growth results in forage production that might be exceeded only by rye; and 3) with spring nitrogen fertilization good grain yield can be expected which has greater economic value per bushel than barley, oats, or rye grain. For pasture only, Balbo rye is desirable because it produced good fall and spring forage yields. Oats produced the

lowest fall and spring forage yields, but may be more desirable than the other crops for hay production if harvested after heading. Oats and barley planted early may be damaged more by the barley yellow dwarf virus than wheat or rye. Barley forage yields in the fall were high, but slightly lower than wheat or rye in the spring. Barley normally heads earlier than wheat or oats and later than rye, so careful observations are necessary to determine when grazing should be discontinued.

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