

RESPONSE OF SEVERAL TAME PASTURE GRASSES TO ALFALFA,  
ALSIKE CLOVER AND KOREAN LESPEDEZA  
IN PASTURE MIXTURES

by

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## INTRODUCTION

The value of including legumes in pasture mixtures has been well demonstrated. In order to evaluate any grass as a possible pasture species for a given region, it would seem desirable to observe the reaction of that species when grown in association with legumes which are adapted to the region. Many species of pasture grasses and several legumes are adapted to the climate and soils of southeastern Kansas, and each has certain desirable characteristics for specific uses. There was a need for testing some of these grasses and legumes in various combinations.

## REVIEW OF LITERATURE

Literature bearing upon this subject reveals that previous work has dealt largely with comparisons of pure stands with associations as they affect the relative performance of different strains within a species. Results reported on these studies are somewhat contradictory.

Wilsie (6), working with several bromegrass strains in legume associations, found that the grass strains were not differentially affected by growing in associations with alfalfa, ladino clover and birdsfoot trefoil. He noted, however, that bromegrass strain differences were greater

when seeded alone than when in association with a legume. In a similar study with orchardgrass strains, Weiss and Mukerji (5) found that the yields of grass strains broadcast in pure stands were closely correlated with their yields in alfalfa and birdsfoot trefoil associations. In their study they noted a differential effect of legumes on grass strains in the first season but not over a three-year period. Torrie and Allison (4) found that the relative performance of several red clover strains was not differentially affected by growing in association with timothy.

On the other hand, it was noted by Churchill (2) that strains of brome grass showing marked differences in aggressiveness in pure stands did not show the same differences in competition with alfalfa. Churchill found that differences in total yield between brome grass strains were greater when strains were grown alone than when grown in mixtures with alfalfa, but, considering yields of grass portions separately, strain differences were greater in alfalfa mixtures than in pure stands. Myers and Garber (3), working with clones of bluegrass, observed that aggressiveness of a grass in pure stand is not always associated with productiveness in a legume association.

Aberg et al. (1) studied paired associations of several species of grasses and legumes in all possible combinations and observed that yield components of members of an association were largely compensating. In no case in their study did an

association have a depressing effect on total yield. They found brome grass to be a stronger competitor than orchardgrass or timothy when each was grown in combination with each other and with alfalfa and red clover. Timothy was the weakest competitor of the three grasses. Wilsie (6) observed the same relationship among these grasses in their ability to compete in association with alfalfa. The difference between brome grass and orchardgrass, however, was small in both cases.

#### MATERIAL AND METHODS

The study reported herein was designed to measure the response of seven introduced cool-season pasture grass species, each grown in association with three different legumes and alone with and without nitrogen fertilization. Grasses included in the study were brome grass, orchardgrass, timothy, redtop, tall fescue, domestic ryegrass and intermediate wheatgrass.<sup>1</sup> The legumes were Buffalo alfalfa, alsike clover and Korean lespedeza.

A split-plot design with three replications was used. The grasses were planted in rows spaced 1 foot apart in plots 9 x 95 feet. Five treatments distributed at random among

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<sup>1</sup> Bromus inermis Leyss., Dactylis glomerata L., Phleum pratense L., Agrostis alba L., Festuca elatior var. arundinacea (Schreb.) Wimm. (Kentucky 31 strain), Lolium multiflorum Lam., and Agropyron intermedium (Host) Beauv.

five sub-plots were: (a) Buffalo alfalfa interplanted, (b) alsike clover interplanted, (c) Korean lespedeza interplanted, (d) nitrogen fertilizer applied at the rate of 50 pounds N per acre, and (e) no treatment. The legumes were drilled in rows between the 1-foot grass rows. The no-treatment plots were double planted with grass making the row spacing 6 inches instead of 1 foot. Unintentionally, the nitrogen plots were not double planted but left as 1-foot rows; however, the stands of lespedeza in the plots where this legume was sown were so nearly complete failures that the lespedeza treatment served, in fact, as a suitable check for the nitrogen treatment.

The experiment was established in the fall of 1949 on Parsons silt loam of medium fertility at the Mound Valley Branch Experiment Station located in southeastern Kansas. A soil treatment of ground limestone at the rate of  $2\frac{1}{2}$  tons per acre, rock phosphate at the rate of 1000 pounds per acre, and a starter fertilizer of the formula 25-50-25 was applied uniformly over the entire plot area and worked into the soil prior to planting.

All grasses and legumes in the experiment, with the exception of the warm season annual, Korean lespedeza, were planted in September, 1949. Korean lespedeza was planted in March, 1950. The nitrogen treatment was applied March 13, 1950.

It was assumed that there could be a relatively wide latitude in rate of planting without significantly affecting yield so long as the rate of planting was sufficient to produce a solid or nearly solid stand in the row. Accordingly the rates of planting were approximately as follows:

	lbs/acre
bromegrass	10
orchardgrass	10
domestic ryegrass	10
tall fescue	10
intermediate wheatgrass	10
timothy	6
redtop	5
alfalfa	8
alsike clover	6
lespedeza	12

Forage yields were measured from two cuttings made at a height of approximately 2 inches using a 3-foot mower of the sickle bar type. An area 3 x 16 feet was harvested for yield from each plot in the first cutting and an area 6 x 16 feet in the second. A moisture sample was taken from each plot sample immediately after weighing to permit the computation of yields on an air dry basis.

Yield components of grass and legume were determined by taking separation samples from each plot prior to harvesting yield samples. Two samples, which were pooled, were cut from

each grass-legume plot. Sampling was done with a wooden hoop 2 feet square which was put down at random and oriented in such a way that the same row length of grass and legume was included in each sample.

The first cutting was harvested on June 17, 1950, at which time the stages of maturity of all the grasses except perennial ryegrass were closely comparable. Perennial ryegrass seed was near maturity; bromegrass and tall fescue were about six days past anthesis; orchardgrass and intermediate wheatgrass were at anthesis; timothy and redtop had headed but were not yet at anthesis.

As a result of unusually favorable growing conditions during the month of July, sufficient growth had been made to permit a second cutting on August 8.



Table 1. Analysis of variance of total forage yields.

Source of variation	: Degrees : : freedom :	Mean square		
		: First cutting:	: Second cutting:	: Season total
Grasses	6	40.14**	4.40**	23.22**
Replications	2	2.20	0.33	4.00
Error (a)	12	2.64	0.53	4.34
Treatments	4	22.91**	9.64**	20.66**
Treatments x grasses	24	3.62	0.33**	4.29*
Error (b) <sup>1</sup>	54	2.33	0.13	2.42

\* significant at 5% level

\*\* significant at 1% level

<sup>1</sup> Data for two missing plots were calculated with a loss of two degrees of freedom in error (b)

Table 2. Yields of total forage by grass species. Means of all treatments in pounds air dry weight per 1/450 acre plot.

Grass species	Forage yield		
	First	Second	Season
	cutting	cutting	total
	lbs		
Intermediate wheatgrass	7.4	1.6	9.0
Redtop	6.9	2.1	9.0
Bromegrass	7.4	2.5	9.9
Timothy	9.7	1.7	11.4
Domestic ryegrass	10.4	1.1	11.4
Tall fescue	7.3	2.3	9.6
Orchardgrass	5.7	2.5	8.2
Mean	7.8	2.0	9.8
LSD 5% level	1.3	0.27	1.7
1% level	1.8	0.81	2.3

Table 3. Yields of total forage by treatments. Means of all grass species in pounds air dry weight per 1/450 acre plot.

Treatment	Forage yield		
	First cutting	Second cutting	Season total
	lbs		
Nitrogen	9.1	2.2	11.3
Lespedeza	8.2	1.5	9.7
No treatment	7.5	1.2	8.7
Alfalfa	6.3	3.0	9.2
Alsike clover	8.1	2.0	10.1
Mean	7.8	2.0	9.8
LSD 5% level	0.94	0.22	0.96
1% level	1.3	0.29	1.3

Table 4. Yields of grasses and legumes in association. Means of three replications in pounds air dry forage per 1/450 acre plot.

Grass species	Grass portions			Legume portions				
	First cutting	Second cutting	Second cutting	First cutting	Second cutting	Second cutting		
	: Alfalfa : Alsike	: Alfalfa : Alsike	: Alfalfa : Alsike	: Alsike :	: Alsike :	: Alsike :		
	: treatment: treatment: treatment:	: treatment: treatment: treatment:	: treatment: treatment: treatment:	: Alfalfa: clover: Alfalfa: clover	: Alfalfa: clover: Alfalfa: clover	: Alfalfa: clover		
	lbs							
Intermediate wheatgrass	3.8	5.5	0.5	0.4	1.0	3.6	2.2	1.5
Redtop	3.1	4.3	1.2	1.1	1.9	2.1	1.6	1.0
Brome grass	3.4	5.5	1.7	1.2	1.4	3.4	1.6	1.1
Timothy	6.7	7.2	1.0	1.1	1.7	2.1	1.7	0.7
Domestic ryegrass	7.9	8.1	0.3	0.2	1.5	1.4	2.0	0.9
Tall fescue	4.7	6.2	1.0	1.4	1.4	1.9	2.4	1.0
Orchardgrass	4.2	3.4	0.9	1.0	1.3	2.2	2.4	1.0
Mean	4.8	5.7	0.9	0.9	1.5	2.4	2.0	1.0

Table 5. Analysis of variance of forage yields by grass and legume components.

Source of variation:	Degrees of freedom:	Mean square			
		Grass portion: First cutting:Second cutting:	Grass portion: Second cutting:First cutting:	Legume portion: First cutting:Second cutting:	Legume portion: Second cutting:First cutting:
Grasses	6	16.37**	1.06**	0.73	0.33
Replications	2	0.60	0.04	0.66	0.02
Error (a)	12	1.09	0.03	0.33	0.24
Legumes	1	8.87**	0.00	8.97**	9.62**
Legumes x Grasses	6	2.14*	0.22	1.49	0.21
Error (b) <sup>1</sup>	12	0.64	0.28	0.71	0.10

\* significant at 5% level  
 \*\* significant at 1% level

<sup>1</sup> Data for two missing plots were calculated with a loss of two degrees of freedom in error (b).

Table 6. Second cutting yields of total forage by grasses and treatments. Means of three replications in pounds air dry weight per 1/450 acre plot.

Treatment	Total forage yield								Mean	
	: Intermediate:	: Brome-:	: Domestic:	: Tall :	: Orchard-:	: wheatgrass:	: Redtop:grass:	: Timothy:ryegrass:		: fescue :
	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
Nitrogen	1.5	2.4	2.6	2.6	0.6	2.6	2.6	3.2	2.2	2.2
Lespedeza	0.9	1.8	2.3	1.0	0.6	1.7	2.3	1.5	1.5	1.5
No treatment	0.9	1.5	2.0	0.6	0.6	1.3	1.5	1.2	1.2	1.2
Alfalfa	2.7	2.8	3.4	2.7	2.4	3.3	3.3	3.0	3.0	3.0
Alsike clover	1.9	2.1	2.4	1.8	1.2	2.5	2.1	2.0	2.0	2.0
Mean	1.6	2.1	2.5	1.7	1.1	2.3	2.5	2.0	2.0	2.0

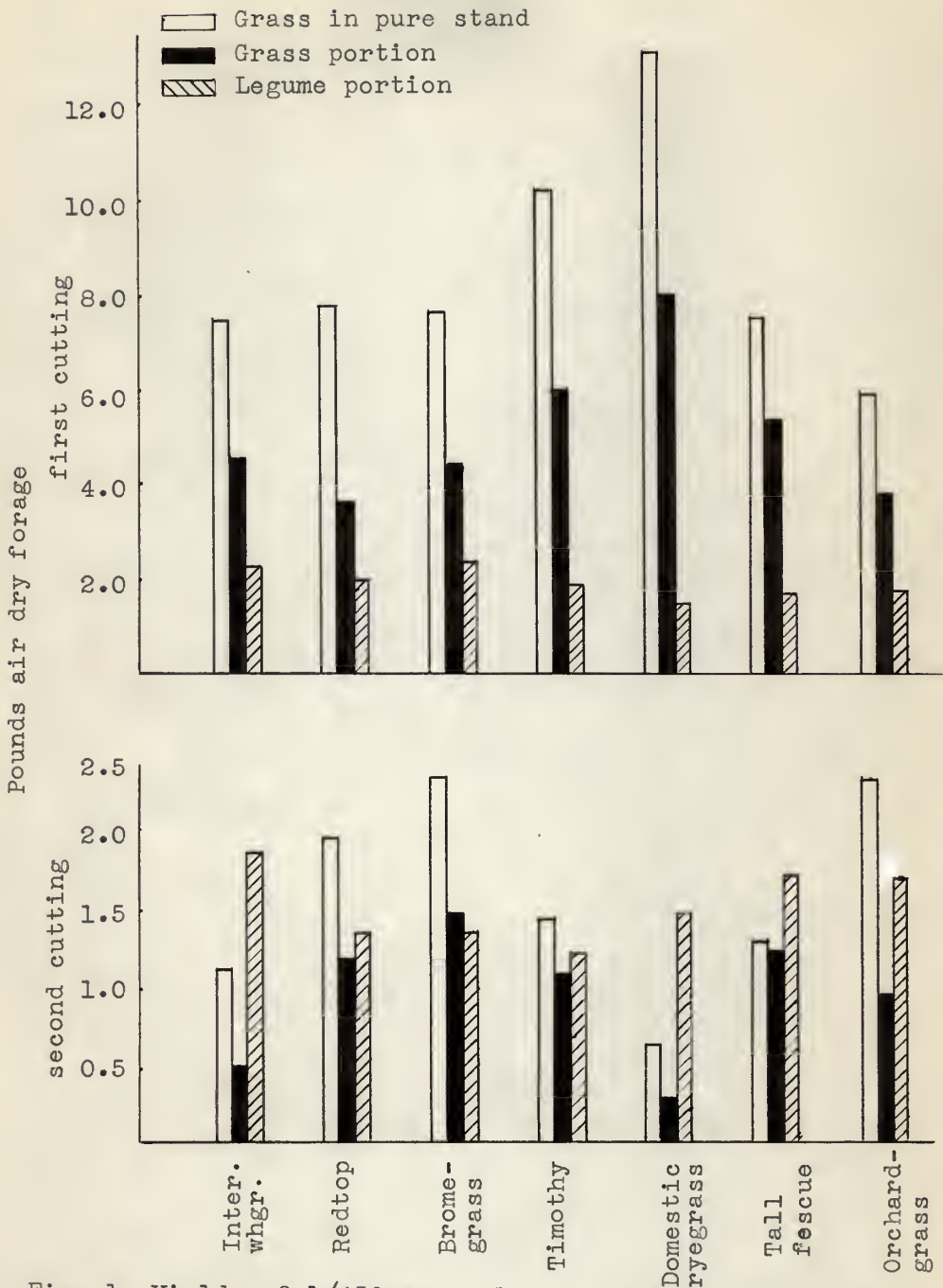


Fig. 1. Yields of 1/450-acre plots of grass in pure stand, grass portion and legume portion in grass-legume associations. Yields are average of three replications. Yields of pure stands are average of three treatments, and portion yields are average of two treatments.

## RESULTS

Excellent stands of timothy, redtop, bromegrass, domestic ryegrass, alfalfa and alsike clover were obtained in all replications, the average stand for each species being 95 per cent or above. Stands of orchardgrass were deficient in all replications, the average stand of this species in all plots being 75 per cent. The average stand of intermediate wheatgrass was 79 per cent, and the average of tall fescue was 90 per cent. However, from an observation of the data, yields did not appear to be closely associated with stand differences, and no adjustments in yield for stand were attempted.

Stand percentages were calculated by measuring the total length of blank row space excluding blank spaces of one foot or less. Total row length per plot minus length of blank row space was considered stand.

The analysis of variance for forage yields is summarized in Table 1. All data are computed on the basis of a 6 x 16 feet plot area which is the size of plot harvested in the second cutting. Yield differences between grasses and between treatments were highly significant in each cutting and in season total. The interaction between grass species and treatments was highly significant in the second cutting, significant at the 5 per cent level in season total, and not significant in the first cutting.



Mean yields by grasses for each cutting and for the season are recorded in Table 2. In the first cutting domestic ryegrass and timothy yields were significantly higher than the other grasses, and orchardgrass yield was low.

The importance of extending the grazing season well into the summer focuses special attention on second cutting yields. Yields of the second cutting tended to compensate for differences in first cutting yields. Grasses that yielded well in the first cutting were low yielders in the second, and vice versa. Thus differences in total yields for the season were less marked than in either cutting.

Mean yields by treatments for each cutting and for the season are recorded in Table 3. Nitrogen fertilization of grasses in pure stands gave higher yields in the first cutting than were obtained from grass-legume associations. Lespedeza was completely absent due to stand failure, so all plots of the lespedeza treatment were, in effect, stands of grass in rows 1 foot apart, comparable, therefore, to the plots receiving nitrogen fertilizer. The 1-foot spacing of grasses in the lespedeza treatment resulted in a slightly higher yield than did the 6-inch spacing of the no-treatment plots. Yields were significantly depressed in the alfalfa associations.

The alfalfa-grass associations gave the highest yields in the second cutting. The relative increase from nitrogen over no-treatment was greater in the second cutting than in

the first.

Considering the combinations of grass-alfalfa and grass-alsike clover, together, the grass portion comprised 73 per cent of total forage yield in the first cutting and 38 per cent in the second. Mean weights of grass and legume portions of these two treatments are shown in Table 4. Grass and legume portions were analyzed separately for variance in both cuttings as summarized in Table 5. In the first cutting both grass and legume components of yield on the alsike clover plots were significantly higher than on the alfalfa plots. In the second cutting, grass portion means were equal for the alfalfa and alsike treatments, but the legume portion was significantly higher for alfalfa than for alsike clover. Differences between grass species in yields of grass portions were highly significant in both cuttings. Also, there was a significant interaction effect between grass species and legumes on yields of grass portions in the first cutting but not in the second. Legume yields in associations were not significantly affected by different grass species, nor was there any significant interaction effect on legume yields.

The relative performance of grass species in legume associations as compared to pure stands, Fig. 1, appeared to be unchanged in the first cutting, but differential effects seemed apparent in the second cutting. Grass portion yields of tall fescue in particular, when compared to the

average yield in pure stands, were depressed relatively little by the competition of legumes.

#### DISCUSSION

It is evident from the analysis of yield data by cuttings that many of the differences can be attributed directly to seasonal growth habits of the individual grass species. Domestic ryegrass behaved as a winter annual, and its total seasonal growth was largely complete by the time of the first cutting. The second cutting yields of intermediate wheatgrass and timothy were low both in pure stands and in association with legumes, indicating that their season of maximum growth does not extend so late as that of bromegrass, orchardgrass, tall fescue and redtop. While differences in total seasonal yields of grass species were highly significant, when considered separately by cuttings these differences were considerably greater.

The effect of alfalfa on all grass species in the first cutting is of particular interest. Soil moisture was apparently the limiting factor on plant growth during early spring, 1950. The alfalfa plots appeared to be affected most by the drouth conditions which prevailed at that time. Although soil moisture was ample later in the spring, alfalfa did not respond so rapidly to the more favorable growing conditions in that period previous to the first cutting as did either

alsike clover or the grass in pure stands. The stage of development of the alfalfa was, of course, not so advanced as that of alsike clover nor did it yield so much as alsike clover, yet alfalfa exerted a greater competitive effect upon the grass portion of the association than did alsike clover, Table 4. In the second cutting alfalfa yielded significantly more than alsike clover without depressing the yields of the accompanying grass any more than did alsike clover.

The general effect of nitrogen fertilization was to extend the growing season of the grasses as is evidenced by the relatively greater response to nitrogen in the second cutting than in the first, Table 3. Domestic ryegrass was the only exception to this trend, Table 6. However, its seasonal growth was so nearly complete by the time of the first cutting that any effect that nitrogen may have had in prolonging growth probably would have been included within the first cutting. Without considering domestic ryegrass, there was still considerable differential response of grass species to nitrogen fertilization in the second cutting. The response of bromegrass to nitrogen was less than that of timothy, for example. This differential response of the grass species to nitrogen fertilization apparently accounts for a large part of the highly significant treatment x grass interaction in the second cutting.

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A study of the response of seven introduced, cool-season pasture grass species to alfalfa, alsike clover and Korean lespedeza in associations and to nitrogen fertilization in pure stands was conducted on Parsons silt loam at Mound Valley, Kansas in 1950. The experiment was arranged in a split-plot design with grass species as main plots and legume associations and nitrogen fertilization as sub-plots.

In average of all treatments for the total season, timothy and domestic ryegrass each yielded significantly more forage than did orchardgrass, tall fescue, redtop or intermediate wheatgrass. Bromegrass yield was intermediate. Second cutting yields of bromegrass, orchardgrass, tall fescue and redtop were significantly greater than timothy, intermediate wheatgrass or domestic ryegrass.

The general effect of nitrogen fertilization was to extend the growing season of the grasses, the relative increase in yield from nitrogen being considerably greater in the second cutting than in the first. Grass species showed marked differences in their response to nitrogen fertilization in second cutting yields.

The average yield of alfalfa-grass associations was significantly lower than any other treatment in the first cutting and significantly higher than any other in the second.

The relative performance of grass species in second



cutting yields appeared to be differentially affected by growing in legume associations as compared to pure stands.

Yields of legumes in associations were not significantly affected by different accompanying grass species.