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LATE SUMMER ESTABLISHMENT OF ALFALFA AND BIRDSFOOT TREFOIL AS RELATED TO DATE AND METHOD OF SEEDING

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Perennial legume seedings are commonly made during the spring. Such seedings permit forage species to become well established prior to the onset of winter. To prevent weed growth, control erosion, and provide an early harvestable crop, spring seedings are frequently accompanied by a companion crop such as a spring cereal. While companion crops may successfully suppress the ingress of weeds they may also depress the growth of the underseeded forage. Recently, spring seeded legumes have been established using a selective herbicide rather than a companion crop to control weed growth. However, yields of dry matter in the establishment year are generally mediocre and the possibility of erosion is still present.

An alternative to spring seeding is a late summer or early fall seeding. Such seedings are usually made without a companion crop and weeds are less troublesome. However, timing is important since the newly seeded species must be sufficiently established and cold tolerant if they are to survive the oncoming winter.

This study was initiated to determine, (a) the date beyond which late summer seedings of alfalfa (Medicago sativa L.) become untenable under Connecticut conditions, and (b) the use of the band seeding technique as an adjunct to such seedings of both alfalfa and birdsfoot trefoil (Lotus corniculatus L.).

LITERATURE REVIEW

Spring seedings of both alfalfa and birdsfoot trefoil may be accompanied with either a companion crop or a selective herbicide. The companion crop exerts considerable competition on the forage legume, especially on a slow developing species such as birdsfoot trefoil. When an oat (Avena sativa L.) companion crop was allowed to develop to a mature stage, available light and soil moisture became limiting factors for alfalfa growth (Klebesadel and Smith, 1960). The seedling growth of birdsfoot trefoil is less than that of alfalfa and a reduction, therefore, in the amount of light reaching birdsfoot trefoil seedlings may affect the ability of these plants to compete for nutrients and moisture (Gist and Mott, 1957).

While a companion crop will exert considerable competition on a forage seeding, Peters (1961) concluded that recovery following the removal of oats under favorable growing conditions would be rapid with alfalfa but not with birdsfoot trefoil. However, in a dry year even alfalfa did not make satisfactory regrowth following the removal of an oat companion crop. Similarly, Scholl and Staniforth (1957) found companion crops to significantly reduce stands and yields of birdsfoot trefoil. Superior stands of birdsfoot trefoil were obtained when the companion crop was omitted and weeds controlled either by hand weeding, the use of a herbicide, or the combination of herbicides and mowing. The cooperative report of Sprague et al. (1963) suggests that early and frequent clipping of a companion crop is beneficial for a spring-seeded birdsfoot trefoil stand. Further, delays in the date of spring seeding will cause depressions in the yield obtained from birdsfoot trefoil (MacDonald, 1946).

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The use of a herbicide as a component of a seeding program for either alfalfa or birdsfoot trefoil facilitates establishment. However, the yield of dry matter in the seeding year may be limited. Kust (1968) concluded that alfalfa established using herbicides was relatively unproductive in the seeding year and that greater total dry matter yields would be obtained if a companion crop was used and harvested for forage. A similar conolusion was reached by Buxton and Wedin (1970). Schmid and Behrens (1972) indicated that alfalfa established in oats harvested for grain and straw was economically more favorable than alfalfa established with herbicides. Though stand counts, taken in the fall of the establishment year, were usually higher for alfalfa seeded alone than with a companion crop, yields in the following year were unaffeoted. Lucey, Seaney, and Burt (1971) however, compared yields from alfalfa established alone and underseeded with a companion crop. The latter method resulted in the greatest forage yield in the year of establishment. Over a three year period, however, alfalfa established alone resulted in the highest total yields. Alternatively, Wakefield and Skaland (1965) reported that herbicide treatments increased the yields of alfalfa and birdsfoot trefoil in the seeding year, compared to untreated plots, but that in the second year the previously untreated plots produced the greatest yields.

Late summer and fall seedings of some perennial forages are possible on soils which are nonerodable. Such seedings may fail because of moisture limitations or when crops do not become sufficiently established prior to the onset of winter. Buxton and Wedin (1970) concluded that a summer seeding of alfalfa, smooth bromegrass (Bromus inermis Leyss), reed canarygrass (Phalaris arundinacea L.), and orchardgrass (Dactylis glomerata L.) was an acceptable method of establishment.

Seeding technique also influences the success of new seedings. The use of the band seeding technique has been cited as resulting in improved stands of alfalfa and birdsfoot trefoil (Tesar, Lawton, and Kawin, 1954). Legume seed banded directly over fertilizer rows resulted in significantly more seedlings and increased seedling vigor than were obtained by broadcasting seed on similarly fertilized soil. Sheard, Bradshaw, and Massay, (1971) similarly reported increased phosphorus uptake from fertilizer placed immediately below surface-sown seed of alfalfa and bromegrass. Dispersing the phosphorus throughout the soil or on the soil surface, decreased phosphorus uptake.

Greater seedling growth of alfalfa as a result of banding superphosphate - compared to mixing the same amount of fertilizer in the soil - was also observed by Brown (1959). However, subsequent yields did not differ. A three year cooperative study, reported by Brown et al. (1960), showed that while band seeding was a good method for grass-legume establishment, it was superior to broadcast seeding only on soils with low fertility levels and during seasons when environmental conditions were unfavorable. Similarly, Carmer and Jacobs (1963) reported that band seeding of alfalfa in the late summer proved advantageous over broadcast methods only when environmental conditions following seeding were unfavorable.

MATERIALS AND METHODS

Experiments were established in the late summer of 1968, 1969, and 1970. Each was established on a Paxton fine sandy loam soil at the Agronomy Research Farm, Storrs, Connecticut.

1968 Experiment

Soil samples were taken from the experimental area in December, 1967. Analysis indicated a pH of 6.3, and calcium (Ca), magnesium (Mg), phosphorus (P) and potassium (K) levels of 2200, 500, 6, and 210 lb/acre, respectively. Consequently, in April 1968, 2500 lb/acre of dolomitic limestone was applied and plowed down. A subsequent broadcast application of 40, 35, and 67 lb/acre of N, P, and K respectively, plus 10 lb/acre of borax, was made and disked in. The area was summer fallowed, disked, and culti-packed prior to fall seeding.

'Saranac' alfalfa at 12 lb/acre and 'Viking' birdsfoot trefoil at 6 lb/acre were seeded on four consecutive dates: July 23, August 14, September 4, and September 16, 1968. Two methods of seeding were used. The first method involved a grain drill which banded the seed at the indicated rates and, in addition, banded 20% superphosphate at a rate of 400 lb/acre (35 lb/acre P) below the seed. Following press wheels firmed the seed in the rows. The second technique involved seeding with the grain drill but without drilling the fertilizer. The fertilizer was broadcast by hand following the seeding, raked into the seedbed, and cultipacked. These plots are referred to as drilled since the seed was not banded above the P fertilizer. The experiment was set out in a split-split plot design replicated five times. Dates of seeding represented main plots, species were split-plots, and methods of seeding were the split-split plots. The size of the split-split plots was 7 x 23 feet.

In 1969 applications of fertilizer supplying 26 and 100 lb/acre of P and K, respectively, were applied April 21 and July 23. Three harvests of the alfalfa and two of the birdsfoot trefoil plots were taken. The first two harvests of both species were taken June 9 and July 18, while the third alfalfa harvest was taken on September 10. In 1970 a single harvest was taken on June 4.

1969 Experiment

The area used was adjacent to that used for the 1968 fall seedings and had been identically fertilized in 1968. Seeded to alfalfa in 1968, fertilized with 52 and 200 lb/acre of P and K, respectively, the area was plowed in July, disked and fallowed.

Saranac alfalfa and Viking birdsfoot trefoil were seeded using the procedures outlined previously. Seedings were made August 8, August 15, August 25, and September 2, 1969. Three harvests were taken from plots surviving the 1969-70 winter. These were obtained on June 4, July 17, and August 31. On May 5 a fertilizer application supplying 39 and 150 lb/acre of P and K, respectively, was made. A single harvest, taken on June 4, was obtained in 1971.

The experimental design was identical to that used for the 1968 Experiment.

1970 Experiment

The area used for this experiment was plowed in the summer. On July 31, 1970, 40, 39, and 150 lb/acre of N, P, and K, respectively, were broadcast and disked in. Saranac alfalfa was band seeded on August 24, August 31, and September 8 at a rate of 12 lb/acre. Superphosphate (46%) was banded at 200 lb/acre. The experiment was set out in randomized complete blocks and replicated four times.

A soil sample was taken in the spring of 1971. Analysis indicated a pH of 6.9, and Ca, Mg, P, and K levels of 2400, 500, 6, and 260 lb/acre. On April 20 plots were topdressed with 20 and 75 lb/acre of P and K respectively. Three harvests, obtained on June 1, July 16, and September 16, were taken in 1971.

RESULTS AND DISCUSSION

Weather data

Weather data, pertinent to the periods immediately affecting the dates of seeding used in the three experiments, are given in Table 1. In 1968 the late summer and early fall mean temperatures were slightly above the average while the precipitation was consistently below average. Precipitation in the corresponding period in 1969 was above average, though the precipitation varied considerably from month to month. The mean temperatures were slightly above average. In 1970 precipitation was consistently below while temperatures were consistently above the long term averages.

Table 1. Precipitation and temperature values for the late summer and fall periods of 1968, 1969, and 1970 at Storrs, Connecticut

	Year					
	1968		1969		1970	
	Observed	Deviation	Observed	Deviation	Observed	Deviation
	Rainfall					
	inch					
July	1.57	-2.34	6.59	+2.68	0.78	-3.13
August	3.39	-1.55	2.51	-2.40	4.78	-0.16
September	2.56	-1.53	6.77	+2.68	3.28	-0.81
October	2.14	-1.34	2.10	-1.38	2.62	-0.86
	Temperature					
	°F					
July	70.7	+0.7	68.5	-1.5	70.8	+0.8
August	67.7	-0.6	70.7	+2.4	70.5	+2.2
September	62.9	+1.8	62.4	+1.3	61.7	+0.6
October	53.7	+2.1	51.7	+0.1	52.8	+1.2
	Clear days					
	%					
August	68		45		65	
September	70		57		60	
October	52		52		52	
November	30		27		27	
First fall temperature of						
32°F	October 31		October 23		October 17	
28°F	November 14		October 23		October 28	
24°F	November 20		October 24		November 24	

In all three years the first fall temperature of 32°F occurred considerably later than the average (October 8). However, in 1969 the first fall temperatures of 32, 28, and 24°F all took place over a span of two days, i.e., October 23-24. In both 1968 and 1970 the first fall temperature of 24°F did not occur until almost one month later. The probability, calculated from the long term climatological data for Storrs, for the first fall temperature of 24°F having occurred by October 26 is 1 in 4, while the corresponding probability for the November 24 date is 9 in 10 (Brumbach, 1965). This suggests that in 1969 the October 24 date at which a low of 24°F was recorded was rather early while in 1968 and 1970 the dates for the corresponding temperature were rather late.

In both 1968 and 1970 a greater percentage of clear days occurred in August and September compared to these same months in 1969. In all three years the percentage of clear days occurring in October and November was essentially identical.

1968 Experiment

Analysis of variance of yield data obtained in 1969, from the 1968 seeding, indicated that both date of seeding and species main effects were significant ($P<0.01$). Values for the various treatments are shown in Table 2. As the date of fall or summer seeding was delayed beyond July 23, yields of dry matter progressively decreased. Seedings of alfalfa made on September 16 failed to survive the winter. Seedings made on September 4 gave an average yield of 4.35 tons/acre, but this was 1.04 tons/acre less than the yield obtained from the July 23 alfalfa seeding. Yields from the birdsfoot trefoil were, as might be expected, considerably less than those from alfalfa. Both the September 4 and 16 seedings failed to survive the winter, a fact contributing to the significant species x date of seeding interaction ($P<0.01$).

There was no significant difference between the two methods of seeding. Similarly, both of the single order interactions, method of seeding x date of seeding and method of seeding x species, also were not significant. The second order interaction, however, was significant ($P<0.05$). As the date of seeding was delayed, yields of alfalfa from band seeded plots were slightly higher than those from drilled seeded plots. The reverse was true for birdsfoot trefoil. That birdsfoot trefoil does not respond to band seeding to the same degree as alfalfa has been noted previously (Duell, 1964).

The birdsfoot trefoil plots became badly infested with broadleaf weeds. This necessitated hand separations in both the first and second harvests in 1969. By September plots were so badly infested that yields were not taken. The birdsfoot trefoil did not survive the 1969-70 winter. In 1970 only the alfalfa plots were harvested and analysis of variance was restricted to the July 23, August 14, and September 4, 1968 dates of seeding.

Analysis of variance indicated that, insofar as the first harvest yields in 1970 from the 1968 date of seeding were concerned, there were no significant differences between either of the dates of seeding or method of seeding main effects, nor the first order interaction between these main effects. These data would suggest that depressions in yield, observed as a result of delaysd late summer seeding, are restricted to the first harvest year following seeding.

1969 Experiment

All of the birdsfoot trefoil seeded in the late summer of 1969 was winter-killed. Statistical treatment of yield data obtained in 1970 was therefore restricted to that obtained from the alfalfa seeding. Date of seeding, as in the 1968 experiment, significantly ($P<0.01$) affected the yields of alfalfa obtained in the year following seeding (Table 3). Seedings of alfalfa made after August 15 failed to survive the winter. A delay in seeding of seven days, ie., from August 8 to August 15, resulted in a loss of over one half ton of dry matter per acre in the following year.

Table 2. Yields of dry matter obtained from alfalfa and birdsfoot trefoil obtained in the year following seeding (1969) and from alfalfa at the first cutting in the second year following seeding (1970)

Date of seeding 1968	Year and Species								
	1969						1970		
	Alfalfa			Birdsfoot trefoil			Alfalfa		
	Banded	Drilled	Mean	Banded	Drilled	Mean	Banded	Drilled	Mean
	tons/acre								
July 23	5.36	5.41	5.39	2.00	1.47	1.74	1.18	1.10	1.14
August 14	4.98	4.77	4.88	0.59	0.76	0.68	1.17	1.12	1.15
September 4	4.48	4.21	4.35	0.00	0.00	0.00	1.21	1.24	1.23
September 16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean[1]	4.94	4.80	4.87	1.30	1.12	1.21	1.19	1.15	1.17

[1]Mean yield excluding dates for which zero yields were recorded.

These trends are essentially in agreement with those observed in the 1968 experiment. However, in the 1968 experiment alfalfa seeded as late as September 4, survived the winter, forming productive stands that yielded in excess of 4 tons dry matter per acre. A partial explanation for these discrepancies may be found in the date of the first fall freezing period. In 1969 an abrupt and early cold spell occurred between the 23-25 October. A low of 52°F was recorded for October 21, 1969, while on October 23, 24, and 25, 1969 lows of 26, 22, and 25 were recorded respectively. A similar cold spell did not oocur until late November in 1968, nor for that matter, in 1970. The cold spell in October, 1969 had been preceded by a relatively cloudy August and September.

Table 3. Dry matter yields of alfalfa obtained in the year following seeding (1970) and from the first cutting in the second year following seeding (1971).

Date of Seeding	Year					
	1970			1971		
1969	Banded	Drilled	Mean	Banded	Drilled	Mean
	tons/acre					
August 8	3.89	3.18	3.54	1.84	1.67	1.76
August 15	3.00	2.97	2.99	1.67	1.74	1.71
August 25	0.00	0.00	0.00	0.00	0.00	0.00
September 2	0.00	0.00	0.00	0.00	0.00	0.00
Mean[1]	3.45	3.08	3.27	1.76	1.71	1.74

[1]Mean yields excluding dates for which zero yields were recorded.

In 1970 there was no significant difference between yields of alfalfa obtained from band seedings compared to drilled seedings. This was also in agreement with the previous years' results. However, the trend was for the band seeded stands, at least from the earliest seeding, to yield greater quantities of dry matter than the drilled seedings.

Analysis of variance of the first harvest yields obtained in 1971 from the plots seeded in 1969, and which survived the 1969-70 winter, indicated no significant differences in yield on the basis of the 1969 dates of seeding or method of seeding.

1970 Experiment

The mean yields of alfalfa obtained in 1971 from the August 24, August 31, and September 8, 1970 dates of seeding were 3.82, 3.65, and 3.42 tons dry matter per acre. Analysis of variance indicated no significant differences between these values. Trends, however, in this experiment were similar to those observed in the previous experiment in that delays in the date of seeding were detrimental to yields obtainable in the following year.

SUMMARY

'Saranac' alfalfa (Medicago sativa L.) and 'Viking' birdsfoot trefoil (Lotus corniculatus L.) were established at various dates in the late summer - early fall periods in 1968 and 1969. Seedings surviving the first winter were harvested on commercial schedules in the following year. In the second year after seeding a single, early June harvest was taken. Seedings were accomplished using both band and drilled seeding techniques. In 1970 Saranac alfalfa only was band seeded in the early fall and subsequently harvested in 1971.

Alfalfa, but not birdsfoot trefoil, was successfully established from these late summer-early fall seedings. Delays in seeding beyond late July resulted in lowered yields in the succeeding year. Differences in yield resulting from date of seeding were not evident in the first cutting in the second year after seeding. In one year out of three seeding after August 15 resulted in the winter kill of alfalfa stands. Significant differences were not detected between methods of seeding.

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