Characteristics of cereal and ryegrass greenfeeds which contribute to superior herbage yield in late winter

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Abstract

The production of herbage by cereal and ryegrass greenfeeds sown in the late summer/early autumn was measured over the autumn and winter months in two field experiments. All greenfeeds made steady growth in the autumn but few made appreciable growth in the winter. Superior late winter herbage yield was associated with both high yield of herbage in the autumn and capacity to resist winter rotting of accumulated herbage. Early harvest of herbage in the autumn depressed late winter herbage yield because recovery growth was poor.

Introduction

Greenfeed crops are cultivated on Canterbury "mixed" farms in order to provide livestock with ample supplies of palatable and nutritious forage at the end of winter when growth of grass/clover pasture is at a minimum (Rickard, 1968; Rickard and Radcliffe, 1976). A large number of cultivars of a wide range of crops viz., wheat, oats, barley, ryecorn and ryegrass, have been used for winter greenfeed production (Claridge, 1972). Although many have been described and compared (Davies, 1960; Whatman and Allo, 1962; Stephen, Kemp and Todd, 1978), there has been little attempt to identify the particular characteristics which make some more useful for winter greenfeed production than others. In this paper, patterns of herbage production by cereal and ryegrass greenfeed crops in two field experiments are compared so as to identify characteristics which contribute to superior forage yield in late winter.

Methods and Materials

The two field experiments have been briefly reported previously (Stephen *et al.*, 1978), however, some particulars of special relevance to this paper require further explanation. The two field experiments discussed here are identified by their site names, viz., East Eyreton and Rokeby 3 (Stephen *et al.*, 1978).

Seeds of the cereal and ryegrass greenfeeds listed in Table 1 were combine drilled with superphosphate into cultivated seedbeds at East Eyreton in early March, and in late February, at Rokeby 3. Soon after their establishment at East Eyreton the test crops were topdressed with several rates of ammonium sulphate. A nil rate or control treatment was also included. The experimental crops at Rokeby 3 were not treated with fertilizer nitrogen.

In April, some two months after seeding, the first of a succession of "initial" harvests of herbage was taken from each plot in each experiment. Thereafter, at approximately regular intervals further "initial" harvests of accumulated herbage were made in each plot from areas not sampled earlier. Also, at intervals after each "initial" harvest, "regrowth" harvests of herbage were taken from areas on which "initial" harvests had been made. At each harvest the green herbage taken from each plot was weighed and its dry matter percentage determined by standard procedures.

Table 1. Cereal and ryegrass greenfeed crops established at the East Eyreton and Rokeby 3 experimental sites.

	East Eyreton	Rokeby 3
Greenfeed crop		
Amuri Oats	★	★
CRD Ryecorn	★	★
Arawa Wheat	★	
Amuri Oats & Tama Ryegrass		★
Tama Ryegrass		★
Paroa Ryegrass	★	★
Tetraploid Westernwolths Ryegrass	★	
Lochhead's Westernwolths Ryegrass		★
Manawa Ryegrass		★
Ariki Ryegrass		★

The yields of herbage (kg DM ha^{-1}) obtained from the initial harvests were used to define patterns of herbage growth in the period from seeding in the late summer or early autumn through to the end of winter. The yields of herbage obtained from the "regrowth" harvests were used to assess the capacity of each test crop to make recovery growth. Yields of herbage from the initial harvest and the subsequent regrowth harvest(s) from the same area were combined to give estimates of "total" herbage yield over the whole period from seeding to the end of winter.

The herbage yield data were subjected to analyses of variance.

Results

At each experimental site the greenfeeds established well and made steady growth through the autumn months until slowed by the onset of the shorter days and lower temperatures of early winter. All greenfeeds made comparatively little growth in the winter months.

Generally the greenfeeds remained free from pests and diseases. However, at East Eyreton, Arawa wheat and Paroa ryegrass were damaged by larvae of the grass grub beetle, *Costelytra zealandica* (White). At that site the other greenfeeds Amuri oats, CRD ryecorn and a tetraploid Westernwolths ryegrass showed no symptoms of grass grub infestation. At Rokeby 3 CRD ryecorn became heavily infected with leaf rust, caused by *Puccinia recondita* Rob. ex Desm., which progressively depressed herbage yield. The other greenfeeds at Rokeby 3 were not affected by either diseases or pests.

At East Eyreton the applications of ammonium sulphate had small but statistically non-significant effects on greenfeed herbage yields.

At each initial harvest some greenfeeds, notably Amuri oats, in each field experiment significantly ($P<0.05$) outyielded other greenfeeds (Table 2). Generally, greenfeeds which gave the highest herbage yields in the autumn initial harvests also gave superior herbage yields in the later or winter initial harvests. Herbage yields from the autumn initial harvests improved with time but were generally poorer than those obtained from the winter initial harvests. Herbage yields obtained from the winter initial harvests differed little among the winter initial harvest dates.

In each experiment regrowth herbage yields differed significantly ($P<0.05$) between some greenfeeds (Table 3). Generally Amuri oats made poorer recovery growth than any of the ryegrasses. Recovery growth on areas from which autumn initial harvests had been taken was superior to that obtained on areas from which winter initial harvest had been made.

Total herbage yields differed significantly ($P<0.05$) between greenfeeds (Table 4), and were influenced

Table 2. Herbage yields (kg dm ha^{-1}) from initial harvests.

	East Eyreton						Rokeby 3				
Initial Harvest	A	B	C	D	E	F	A	B	C	D	E
Date	26/4	10/5	23/5	9/6	22/6	17/8	9/4	29/4	21/5	2/7	23/7
Crop											
Amuri Oats	1190	1675	2560	3290	3600	5930	2200	4280	6570	6540	6740
CRD Ryecorn	1250	1630	2370	2470	2980	4600	2830	4230	4220	3930	4460
Arawa Wheat	580	730	1040	1190	1330	2520					
Amuri Oats & Tama Ryegrass							1950	4720	6200	7000	6520
Tama Ryegrass							1730	3250	3840	4580	5280
Paroa Ryegrass	825	1065	1760	2020	2490	3960	1660	3590	4370	4900	5600
Tetraploid Westernwolths Ryegrass	1005	1270	2140	2660	2740	4280					
Lochhead's Westernwolths Ryegrass							2130	4140	4630	5330	6040
Manawa Ryegrass							1290	3020	3870	4860	5420
Ariki Ryegrass							1030	2940	3500	4340	4640
LSD (5%)	100	160	200	270	350	610	180	235	235	250	260
LSD (1%)	135	210	265	355	470	825	360	475	475	500	525
CV %	11.5	13.8	11.2	12	14.4	15.5	19.5	12.6	10.2	9.6	10.8

Table 3. Herbage yields (kg dm ha^{-1}) from regrowth harvests taken after initial harvests.

	East Eyreton						Rokeby 3				
Initial Harvest Site	A	B	C	D	E	F	A	B	C	D	E
Number of regrowth harvests	2	1	1	1	1	0	3	3	2	1	1
Crop											
Amuri Oats	1175	270	195	130	100	0	850	0	0	0	0
CRD Ryecorn	2260	990	1020	770	811	0	2070	1370	440	320	80
Arawa Wheat	902	320	310	220	120	0					
Amuri Oats & Tama Ryegrass							1830	1290	620	330	100
Tama Ryegrass							2380	1700	900	620	310
Paroa Ryegrass	2610	1230	1350	870	1090	0	2380	1950	1000	570	310
Tetraploid Westernwolths Ryegrass	2770	1270	1430	980	1130	0					
Lochhead's Westernwolths Ryegrass							2010	1410	550	310	110
Manawa Ryegrass							2360	1470	760	570	210
Ariki Ryegrass							2210	1360	730	510	280
LSD (5%)	230	95	145	55	110		370	265	130	150	100
LSD (1%)	310	130	195	75	150		490	360	180	200	135
CV %	12.8	17.6	18.2	10.0	18.4		18.0	17.5	18.6	31.7	50.5

Table 4. Total herbage yields (kg dm ha^{-1}) from initial harvests and regrowth harvests.

	East Eyreton						Rokeby 3				
Initial Harvest Site	A	B	C	D	E	F	A	B	C	D	E
Crop											
Amuri Oats	2360	1950	2750	3425	3700	5930	3050	4280	6570	6540	6740
CRD Ryecorn	3515	2625	3390	3240	3790	4600	4900	5600	4660	4250	4540
Arawa Wheat	1485	1055	1350	1410	1460	2520					
Amuri Oats & Tama Ryegrass							3780	6010	6820	7330	6620
Tama Ryegrass							4110	4950	4740	5200	5590
Paroa Ryegrass	3435	2290	3105	2890	3580	3960	4040	5540	5370	5470	5910
Tetraploid Westernwolths Ryegrass	3775	2540	3570	3640	3870	4280					
Lochhead's Westernwolths Ryegrass							4410	5550	5180	5640	6150
Manawa Ryegrass							3650	4490	4630	5430	5630
Ariki Ryegrass							3240	4300	4230	4850	4920
LSD (5%)	295	220	280	295	330	610	555	320	135	85	42
LSD (1%)	400	300	380	400	440	825	740	430	180	110	55
CV %	11.0	11.4	10.7	11.0	10.8	15.5	13.8	10.9	9.7	9.2	10.8

mainly by the magnitude of initial harvest and, to a lesser degree, by regrowth harvest yields. Total herbage yields from areas on which an autumn initial harvest and two or more regrowth harvests were taken tended to be poorer than total herbage yields from areas on which a winter initial harvest and no more than one regrowth harvest was taken. Overall regrowth herbage yields contributed little to total herbage yields.

Discussion

In Canterbury, the cultivation of cereal and ryegrass greenfeeds as a means of ensuring ample supplies of nutritious and palatable forage in late winter, requires the seeding of the crops in the late summer/early autumn. The practice of seeding greenfeeds at that time exposes the crops to such conditions as autumn drought, a short growing season and a cold, dank winter, none of which is optimum for vigorous growth and high herbage yield. Consideration of seeding time and environmental conditions commonly experienced by the crops suggests that superior winter greenfeeds are most likely to be those which have substantial capacities to germinate and establish quickly in spite of autumn drought, to make rapid vegetative growth throughout the autumn and winter months, to withstand factors which induce winter rotting of accumulated herbage and to make appreciable recovery growth should it be necessary to graze the greenfeed prior to late winter.

Detailed measurements of germinations and early establishment rates in individual greenfeeds were not made in either field experiment. It is unreasonable therefore to offer conclusive comments regarding the effects of earliness of germination and establishment rates in individual greenfeeds on late winter herbage yields. However, in view of the generally acknowledged harmful effects of drought on seed germination and seedling establishment it may be not unreasonable to note a local conventional wisdom which has it that large seeds which can be drilled more deeply and therefore in closer contact with damper subsurface soil, are likely to germinate more quickly and produce seedlings earlier than less deeply sown small seeds. If this contention is correct it follows, at least in dry autumns, that such crops as oats and ryecorn are more likely to be superior greenfeeds than are ryegrasses.

In both field experiments reported herein, successive initial harvests show that all greenfeeds accumulated significant quantities of herbage in the autumn months but made little additional growth following the onset of winter in early June. Although some ryegrasses achieved marginally higher growth rates in the winter than other greenfeeds, the additional herbage that they accumulated in winter was not sufficient to compensate for their slower growth rates in the autumn. It is concluded, therefore, that at least in the case of the greenfeeds tested, rate of autumn growth is an important factor determining late winter herbage yield, and that winter growth, which barely occurred, is unimportant. This conclusion, however, would need to be revised should a crop with greater capacity for winter growth become available.

The contributions to total herbage yields by regrowth of herbage after an initial harvest differed with time at which the initial harvest was made. Yields of regrowth herbage obtained after the earliest autumn initial harvest amounted to some 50 to 70 percent of total herbage yields, but the position declined with the lateness of the initial harvest. Notwithstanding the high percentage contributions to total herbage yields by regrowth herbage harvested after an early initial harvest their absolute contributions were not sufficient to offset the low herbage yields from the early initial harvests. It must be concluded therefore that recovery growth even after an early initial harvest is not an important factor in determining late winter herbage yield in the cereal and ryegrass greenfeeds tested.

The decline in herbage recovery growth with lateness of initial harvest occurred, in part, because the later the initial harvest, the smaller the opportunity for recovery growth due to the low temperatures of winter. Herbage recovery growth was also affected by forage harvest technique. At each harvest the herbage was cut with hand shears as close to the ground as practicable. That procedure disregarded morphological differences among individual greenfeeds, and thereby severely damaged some crops, notably Amuri oats, more than others. The damage which must be considered a factor responsible for the poor regrowth in the field experiments might be limited by a less severe harvest procedure but such procedures are difficult to operate in field experiments.

Most of the greenfeeds tested remained free from disease and experienced little, if any, winter rotting of accumulated herbage. However, at Rokeby 3, CRD ryecorn became heavily infected with leaf rust and the subsequent winter rotting of herbage was so severe that yields of herbage declined steadily through the winter months. This experience with CRD ryecorn was fortunate in that it emphasised and confirmed the important negative role of winter rotting in determining late winter herbage yield in cereal and ryegrass greenfeeds.

The identification of autumn growth rate and resistance to winter rotting as the most important characteristics that contribute to late-winter herbage yield in late-summer/early-autumn sown cereal and ryegrass greenfeeds, suggests that such crops may be effectively and efficiently compared by measuring their herbage yields in two in harvests, one taken at the end of autumn and the other at the end of winter, and a regrowth harvest taken at the end of winter from areas harvested at the end of autumn, and by assessing the incidence of winter rotting of accumulated herbage.

In summary, the total quantities of herbage yielded by individual greenfeeds in the late winter differed among crops and reflected their capacities to make growth in the autumn months and to resist winter rotting of accumulated herbage.

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