Nitrogen Effects on Tall Fescue Seed Production

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ABSTRACT

There were no significant differences in seed yield of 'Grassland Roa' tall fescue (*Festuca arundinacea* Schreb.) when nitrogen was either split between autumn and spring or applied only in the spring. In older crops (6 and 7 seed harvests) up to a total of 120 kg N ha^{-1} had to be applied for maximum seed yields.

In years when spring nitrogen was applied at stem elongation, seed yields (1034 kg ha^{-1}) were substantially higher than those years when spring nitrogen was applied after stem elongation (682 kg ha^{-1}).

Seed yield increases were caused mostly by increases in spikelets per tiller and florets per spikelet.

Additional index words: **spring nitrogen, autumn nitrogen, stem elongation, spikelets per tiller, florets per spikelet.**

INTRODUCTION

Nitrogen is the most important element influencing seed yield in grasses (Rolston, Brown, Hare and Young, 1985; Hampton, 1988) provided other elements are not limiting. If there are adequate tiller populations in perennial ryegrass, only one application of nitrogen in the spring at stem elongation is necessary for producing high seed yields (Brown, 1977, 1980; Hampton, 1987), and autumn nitrogen is not needed. However, in tall fescue autumn nitrogen application is a common practice because of the autumn and early winter production of inflorescences (Bean, 1978) and the many years that tall fescue stands are harvested for seed.

In the USA on five and eight year old tall fescue stands, 67 kg N ha^{-1} applied in autumn and mid-winter gave similar seed yields to 134 kg N ha^{-1} applied once in the early spring (Kroth, Mattas, Meinke and Matches, 1977). The single spring application caused excessive lodging. On a one year old stand, Watson and Watson (1982) found that 67 kg N ha^{-1} produced similar seed yields to 134 kg N ha^{-1}, but in the second year, the higher rate produced more seed than the lower rate. In Australia, Hill and Blackstock (1983) showed that on nitrogen deficient soils 50 kg N ha^{-1} in both autumn and mid-spring produced the best seed yields on two to three year old tall fescue seed stands.

No previous New Zealand work on the nitrogen requirements for tall fescue seed production has been reported. Applications of nitrogen were based on experience with ryegrass seed crops. In early work (1981-82) we investigated optimum spring nitrogen application rates. As work progressed it was decided to investigate the use of autumn and spring nitrogen.

Perennial ryegrass research indicated that the N required was the difference between the total seed crop requirement (130 kg ha^{-1}; Hampton, Clemence and Hebblethwaite, 1983) and the soil N status (Rolston *et al.*, 1985; Hampton, 1987). Tall fescue may initially require less nitrogen than perennial ryegrass because of its deeper rooting depth and consequent capacity for exploiting soil nutrients. In time, however, tall fescue seed crops may require more nitrogen than ryegrass to maintain seed productivity, as they can be harvested for six consecutive seasons in New Zealand, compared with a single harvest for most perennial ryegrass seed crops.

From 1985 to 1986 we examined the effect of autumn and spring nitrogen application times and rates on seed production in *Festuca arundinacea* cv. Grasslands Roa.

MATERIALS AND METHODS

The trials were conducted over four seasons at the DSIR Grasslands farm 'Aorangi', Manawatu, New Zealand (latitude 40° 23' south), on a poorly drained Holocene quartzo-feldspathic silty alluvium soil (Kairanga silt loam). A pre-basic seed crop of 'Grasslands Roa' tall fescue was established in 1979 (Table 1) and annual seed harvests were taken in December of every year from 1980 to 1986. Nitrogen trials were conducted in 1981, 1982, 1985 and 1986. In 1983 and 1984 closing date trials were conducted in the same field (Brown, Rolston, Hare and Archie, 1988).

Soil samples were taken in August 1985 and 1986 and results from the soil incubation method (Greenwood, Quin and Sinclair, 1982) were used to estimate that the soil N residual levels in both years were c. 1 kg ha^{-1}. In the 1985 and 1986 trials, nitrogen was applied as calcium ammonium nitrate (26% N). Details of experimental management are given in Table 1.

[1]DSIR Grasslands, Private Bag, Palmerston North, New Zealand. Received for publication 16 August 1990.

TABLE 1.
Nitrogen trial details at Aorangi (1981-1986).

Trials	1981	1982	1985	1986
Plot size	3 x 4 m	2.4 x 2.5 m	13 x 3.6 m	10 x 3.6 m
Replications	4	6	4	4
Design	Completely randomised block			
Nitrogen application dates	2 October	14 September	19 April 6 September	2 May 3 September
Growth analysis	10 December	6 December	2 December	3 December
Harvest	27 December	31 December	28 December	22 December
Sowing	9 November 1979, 5 kg ha^{-1}, 60 cm rows.			
Grazing	Grazed by sheep following each harvest until late July/early August of each year.			
Fertiliser	Nitrogen applied in September of each year to areas outside trial at c. 60 kg N ha^{-1}.			
Post-Harvest	Straw baled and stubble hard grazed to 2-3 cm from ground level.			

Spring nitrogen (1981, 1982)

In both years, spring nitrogen (urea) was applied at rates of 0, 40, 80, 120 and 160 kg N ha^{-1} (Table 2). For growth analysis, reproductive tillers were counted in 2 x 1.5 m rows in both years, and 20 (1981) or 30 (1982) reproductive tillers were taken from these rows for spikelet and floret counts. All spikelets on each tiller were counted, while floret counts were made on a spikelet taken from the base, middle and top of each tiller. At seed harvest a 3.6 m^2 (1981) or 1.8 m^2 (1982) area was cut from each plot, placed in a hessian bag, air dried, threshed and cleaned. Seed yields were corrected to 14% seed moisture.

Autumn/spring nitrogen (1985, 1986)

In both years autumn N was applied at rates of 0 and 40 kg N ha^{-1}, autumn plus spring applications were at 40 + 40 and 40 + 80 kg N ha^{-1}, and spring only applications were at 40, 80 and 120 kg N ha^{-1} (Table 3). For growth analysis, reproductive tillers were counted in 4 (1985) or 2 (1986) x 0.5 m rows for each plot. Further samples (0.5 m row in 1985; 0.25 m^2 quadrat in 1986) were cut from each plot for reproductive and vegetative tiller counts and dry weights, and spikelet and floret counts were made as previously described on 30 (1985) or 20 (1986) reproductive tillers per plot. At seed harvest a 3.6 m^2 (1985) or 8 x 0.25 m^2 quadrats (1986) were used. Seed heads were bagged, air dried, threshed and cleaned, and yields corrected to 14% seed moisture.

RESULTS

Spring nitrogen (1981, 1982)

The greatest seed yield came from 80 kg N ha^{-1} in 1981 and 120 kg N ha^{-1} in 1982, although only in the first year was there a significant increase ($P > 0.05$, Table 2). However, in neither year were yields significantly increased by applications rates greater than 80 kg N ha^{-1}, and at this rate, the seed yield increase over that of the control was consistent (36% in 1981 and 37% in 1982). Seed yield component responses were variable (Table 2), but yield responses in both years appeared to be associated with either increased spikelet or floret numbers (Table 2).

Autumn/spring nitrogen (1985, 1986)

Significant seed yield increases were achieved from both split (autumn/spring) and spring nitrogen

TABLE 2.
Effect of spring nitrogen application rate on seed yield and yield components.

Nitrogen (kg ha^{-1})	Seed yield (kg ha^{-1})	Reproductive tillers (m^2)	Spikelets per tiller	Florets per spikelet	T.S.W. (g)
1981					
0	572	536	59.7	5.13	2.79
40	592	486	58.8	5.52	2.84
80	780	560	67.2	5.50	2.68
120	649	492	64.8	5.78	2.89
160	706	473	63.9	6.13	2.75
LSD 5%	195	ns	ns	0.56	ns
1982					
0	292	398	47.0	4.77	-[1]
40	289	384	56.2	4.76	
80	402	367	51.6	4.92	
120	448	525	54.9	4.84	
160	414	426	59.0	5.39	
LSD 5%	ns	113	11.1	0.34	

[1]Data not recorded

TABLE 3.
Effect of autumn and spring nitrogen application rate on seed yield and yield components.

Nitrogen (kg ha^{-1})	Seed yield (kg ha^{-1})	Reproductive tillers (m^2)	Spikelets per tiller	Florets per spikelet	T.S.W. (g)
1985					
0	508	420	37.3	4.53	1.79
40 A[1]	520	517	42.5	4.23	1.61
40 A + 40 S[2]	800	570	57.0	4.32	1.89
40 A + 80 S	850	495	54.2	4.53	1.63
40 S	653	419	46.7	4.60	2.04
80 S	742	450	64.6	4.88	2.03
120 S	862	468	61.5	4.90	1.69
LSD 5%	254	ns	14.7	ns	0.35
1986					
0	620	280	44.7	4.72	1.89
40 A	809	380	58.0	4.68	1.88
40 A + 40 S	1040	329	55.3	4.96	1.91
40 A + 80 S	1323	374	67.4	6.46	2.01
40 S	869	330	58.3	4.92	2.07
80 S	943	284	59.7	5.42	1.91
120 S	1218	375	56.1	5.64	1.96
LSD 5%	269	ns	14.6	1.08	ns

[1] A = Autumn
[2] S = Spring

application in both years (Table 3). However, when the same total N was applied, seed yield did not differ significantly between application times. For example, in both years the seed yield from 40A + 40S did not differ from that of 80S. As in 1981/82, seed yield responses were associated mostly with increased spikelet and floret numbers, as reproductive tiller numbers did not differ in either year (Table 3).

DISCUSSION

No seed yield advantage was gained from splitting nitrogen application between autumn and spring, and providing tiller populations are adequate it would appear that as for perennial ryegrass (Hampton, 1987), autumn nitrogen is not a requirement. However, these data came from only one site and from a well established crop, and it is possible that in new stands and to encourage inflorescence production (Bean, 1978), some autumn nitrogen may be required. It was noted that plants in the 1985 and 1986 plots which did not receive autumn nitrogen showed symptoms of nitrogen deficiency in the winter and early spring, but this was obviously not severe enough to influence seed yield at this site. Further work is required to confirm whether nitrogen application time recommendations for Grasslands Roa tall fescue should be similar to those for crops grown in USA (Kroth *et al.*, 1977).

Seed yields in 1981 (second harvest season) averaged 682 kg ha^{-1} (over all nitrogen treatments, Table 2), but in 1986 (seventh harvest season at the same site) averaged 1034 kg ha^{-1} (over all nitrogen treatments, Table 3). Similar amounts of nitrogen were applied in both years, and the major factor in this yield difference was probably the time of spring nitrogen application. In grass seed crops, nitrogen should be applied just prior to stem elongation (Brown, 1977, 1980); in Grasslands Roa tall fescue, stem elongation occurs in early September at this site (Hare, unpub. data). In 1981, spring nitrogen was not applied until early October, nearly four weeks after stem elongation, whereas in 1986, application was in the first week of September, at stem elongation.

Tall fescue seeds shed readily when ripe (Youngberg and Wheaton, 1979), and any harvest delay can cause large seed losses, especially if heavy rain and strong winds occur. Time of harvest can therefore significantly influence seed yield. In 1982, seed harvest was late (Table 1) and followed a period of very strong wind, so that much seed was deposited on the ground and seed yield was around half of that in 1981. In contrast, the 1986 harvest was one week earlier than previous years, seed shedding had not begun, and seed yield was high.

At this site, the crop required between 80 and 120 kg N ha^{-1} for maximum seed yield, a result similar to that previously reported for perennial ryegrass (Hampton *et al.*, 1983). There was no suggestion that the requirement was any greater in the sixth and seventh harvest seasons than in earlier harvest seasons. This nitrogen rate requirement and effect of crop age response should be further evaluated at other sites.

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