The effects of autumn - stubble treatment and spring nitrogen application on seed yield of browntop (*Agrostis capillaris* L.)

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Abstract

A three year old stand of browntop (*Agrostis capillaris* L.) cv. Grasslands Sefton on the Lincoln University cropping farm was used to investigate the effects of three autumn - stubble treatments and four rates of spring nitrogen on seed yield in the following season. Autumn - stubble treatments (control, mowing or burning) were imposed in April - four weeks after harvest. Spring - nitrogen treatments were 0, 60, 120 or 240 kg N/ha; the total N allocation to each plot was applied in three split applications in early September, early October and early November. Green material was analyzed monthly by AgResearch Invermay Soil Fertility Service for total N. Seed was hand harvested in February, hand threshed and machine cleaned, and seed yield components recorded. Seed yield did not differ significantly among the three autumn treatments, even though mowing (removal of stubble) increased the number of seed heads. Increasing N fertiliser had a significant and positive linear effect ($P < 0.001$) on seed yield. The increase in yield resulted from an increase in yield/head and thousand seed weight which compensated for a significant reduction in heads/m^2 with increasing N. The percentage germination was not affected by N. Herbage N percentage was significantly ($P < 0.001$) increased by nitrogen fertiliser, although the magnitude of the effect decreased with time, and was significantly ($P < 0.001$) correlated with seed yield at all samplings. These data have potential to form the basis of a model to predict and manipulate seed yield.

Additional key words: *Browntop,* Agrostis capillaris *L., seed production, mowing, burning, post-harvest treatment, calcium ammonium nitrate*

Introduction

Browntop (*Agrostis* spp.) is an important amenity species for golf courses and a high value turf grass for home lawns and parks throughout the world (Rumball and Robinson, 1982; Smith *et al.*, 1993). There is considerable potential on the export market for browntop seed, but at present yields are variable (Rowarth *et al.*, 1993b) and recommendations for management not well established (Guy *et al.*, 1990). Major areas for investigation in browntop seed production were identified by Rowarth *et al.* (1993b) as being autumn - stubble management and nitrogen fertiliser use.

Removal of autumn - stubble is thought to be desirable to allow light into the base of the sward to stimulate tillering (Langer, 1990). Browntop stubble is thick and is generally burned off, but the heat generated can cause damage and the smoke generated is atmospherically undesirable. Alternatives include doing nothing or mowing and baling the stubble.

The efficient utilisation of nitrogen fertiliser is a matter of great economic importance. Historically, nitrogen experiments have been based on examining the relationship between the amount of fertiliser N input and the output of grass seed yield in the soil - grass ecosystem (Rowarth and Archie, 1994). However, recommendations based on this method are often "site specific" as soil N and atmospheric N are not considered. Preliminary work with ryegrass has indicated that spring herbage N percentage can be related to seed yield, thus giving an effective diagnostic tool which may avoid "site - specific" problems (Rowarth *et al.*, 1993a); the calibration has not been made for browntop.

The experiment described in this paper was designed to (a) improve understanding of the effects of autumn - stubble burning and mowing on seed production and (b) establish the relationship between herbage N% at different stages, and final seed yield.

Material and Methods

The experiment was conducted on the Lincoln University cropping farm on a fertile Temuka silt loam. Quick test soil analysis results (on 30 July 1992) were P

30, K 22, S 6, pH 5.7. The crop of browntop cv. Grasslands Sefton had been sown in March 1991 at 2.2 kg/ha with 30 cm row spacing.

A field experiment was established using a factorial combination of three autumn - stubble treatments and four rates of spring nitrogen. The experimental design was a 3 X 4 factorial in a randomised complete block with 6 replicates. Plot size was 20 m^2.

Autumn - stubble treatments (3) were: control, mowing or burning. The treatments were imposed in April 1993 (four weeks after harvest) to coincide with on - farm practice at this site. A mechanical mower and fuel - flame burner were used for stubble treatments. The mown plots had stubble completely removed, whereas the control was left with a stubble of 15 cm. Burned plots had only patchy (60 - 70%) stubble removal, as the burning treatment was not as successful as anticipated. Spring nitrogen fertiliser treatments (4) totalled: 0 kg/ha (N0), 60 kg/ha (N1), 120 kg/ha (N2), or 240 kg/ha (N3). Nitrogen was applied as calcium ammonium nitrate (N=27%) on 3 separate occasions (Table 1).

A sample of 0.18 m^2 per plot was harvested fortnightly; green material and dead matter were separated and weighed. Green material was analyzed monthly by AgResearch Invermay Soil Fertility Service for total N (Basson, 1976). Seed was hand harvested (0.36 m^2 per plot) in February and seed yield components recorded. Seed was hand threshed and machine dressed. Seed germination and 1000 - seed weight (TSW) measurements were conducted according to the Association of Official Seed Analysts Rules for testing seeds (AOSA, 1991). Prechilling and alternating day/night temperatures (30/15°C) and light (8 h day/16 h night) were used as outlined by AOSA. Germination of normal seedlings was recorded after 7 and 28 days. The data collected were analyzed using an analysis of variance (ANOVA) or analysis of covariance (ANOCOVA) by software Minitab or Genstat.

Table 1. Timing and amounts of fertiliser nitrogen.

Treatment level	Fertiliser nitrogen (kg N/ha) 8 Sept	9 Oct	11 Nov	Total
N0	0	0	0	0
N1	20	20	20	60
N2	40	40	40	120
N3	80	80	80	240

Results and Discussion

Autumn - stubble treatment effects

Autumn - stubble treatment had no effect on seed yield (average seed yield was 64.42 g/m^2; range 64.22 - 64.77 g/m^2). This result is similar to that reported by Young *et al.* (1993) who found no statistical differences in annual yield as a result of autumn - stubble treatment. However, when yields were summed and analyzed over several years, significant differences did become apparent (Young *et al.*, 1993). There was no significant interactive effect on seed yield between autumn -stubble treatment and spring nitrogen fertiliser application.

The number of heads per m^2 was significantly ($P < 0.001$) increased by autumn - stubble mowing (4764 in the mown plots, cf. 3758 in the control and 3998 in the burned plots). This is consistent with the theory that removal of stubble enhances the penetration of light into the base of grass plants and encourages more tillering (Langer, 1990). However, the increased head population in the mown plots did not lead to increased seed yield in this experiment. Autumn - stubble treatment had no significant effect on herbage N% (average was 3.2%; range 3.1% - 3.3% in October). However, there was a significant ($P < 0.004$) interactive effect on herbage N% between autumn - stubble treatment and N application in October. Herbage N% ranged from 4.0% in mown plots to 3.4% in the control and 3.5% in burned plots when N was applied at the highest rate (80 kg N/ha). The proportion of dead material was much lower in the mown plots (5.8%) than in the control (33.8%) or burned (32.1%) plots. The percentage of dead material was significantly negatively correlated ($P < 0.001$) with herbage N%. It is possible that removal of autumn - stubble allowed nitrogen absorption by the crop, whereas when stubble remained, N was involved in breaking down the dead material.

Spring - N fertiliser application effects

Seed yield (SY; g/m^2) increased as N application rate increased (Table 2), and this relationship was linear, i.e.,

$$SY = 44.9 + 0.187\ N, \qquad r^2 = 49.4\%, \qquad P < 0.001$$

The increase in yield resulted from an increase in yield/head and TSW, which more than compensated for a significant reduction in heads/m^2 with increasing N (Table 2). There was no effect of N on seed germination (average = 95.6%; range 94.8% - 96.5%).

Nitrogen fertiliser had a significant ($P < 0.001$) and positive effect on herbage N percentage at all sampling dates (Fig. 1), although N percentage decreased with time. This is consistent with results found in cereals (Scharrer and Mengel, 1960) and can be attributed to a dilution effect (Mengel and Kirkby, 1987). That is, nutrients such as N are accumulated pre - active growth, resulting in a high concentration in early spring. As growth becomes rapid, the N in the plant is mobilised to new tissue leading to an apparent decrease in tissue concentration although the plant N content changes little.

Table 2. Effects of nitrogen fertiliser on seed yield and its components.

Nitrogen (kg/ha)	Seed yield (g/m^2)[a]	Heads/m^2 (No.)	Seed yield (mg/head)	TSW[b] (mg)
0	44.9 c	4890 a	9.39 b	68.3 d
60	58.5 bc	4450 ab	13.4 b	76.2 c
120	63.8 b	3830 cb	17.4 b	84.5 b
240	90.5 a	3530 c	28.8 a	91.5 a

[a] Means within columns followed by the same letter are not significantly different at 1% level according to Duncan's MRT.
[b] Thousand seed weight.

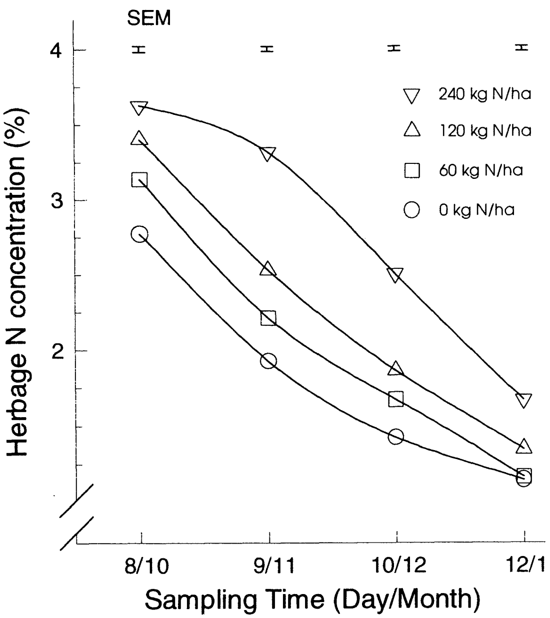

Figure 1. Effect of rate of nitrogen fertiliser on herbage N% with time.

Herbage N% was significantly ($P < 0.001$) correlated with seed yield at all samplings although the highest correlation occurred in December (Fig. 2), i.e.,

$$SY = -6.4 + 38.1 \text{ N\%}; \quad r^2 = 0.49, \quad P < 0.001$$

October, November and December N% were highly correlated with each other ($P < 0.001$). This suggests that it might be possible to influence seed yield by adjusting herbage N early in the season to ensure optimum herbage N% in December.

These data have the potential to form the basis of a model to predict and manipulate seed yield (Rowarth and Archie, 1994); model creation and validation are continuing.

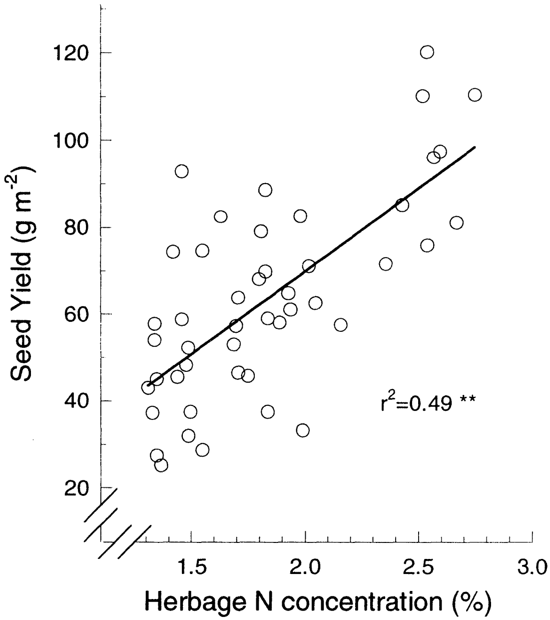

Figure 2. The relationship between seed yield (February) and herbage N% (December).

Conclusions

Autumn - stubble treatment had no significant effect on seed yield in this experiment, despite stubble removal increasing the number of seed heads. In contrast, N fertiliser increased seed yield but decreased the number of seed heads. N fertiliser significantly increased TSW and had no effect on seed germination.

It is tempting to conclude that optimum yields can be obtained from browntop by leaving stubble intact and adding large quantities of nitrogen in the spring. However, bulk material at harvest (which is likely if stubble is not removed) could hinder the harvesting process causing seed loss. Furthermore, this experiment involved only one year in a crop which can be harvested for six years. Another consideration is that over use of nitrogen has the potential for causing environmental contamination; research on fertiliser loss and recovery is necessary in order to quantify nitrogen use efficiency in small seed crops.

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