Recent grass seed production studies in Canterbury

K. R. Brown
Grasslands Division, DSIR, Lincoln

ABSTRACT. Seed production trials in Canterbury have shown (1) strong negative relationships between plant density and seed yields per plant, and (2) plant density ranges above which high plant numbers failed to compensate for low yields per plant and below which high yields per plant failed to compensate for low plant numbers. The net result was that seed yields per unit area tended to plateau at this density range, with no further gains being made by increasing plant numbers. It is concluded that the function of seeding rate is to provide sufficient viable seeds to attain this density. Optimum density ranges for 'Grasslands Tama' Westerwolds ryegrass and 'Grasslands Nui' perennial ryegrass were 300 to 400 plants/m², and for 'Grasslands Matua' prairie grass 100 to 130 plants/m².

The value of superphosphate and potassic fertilizers for seed production was doubtful, but nitrogen increased seed yields regardless of time of application. Work in Canterbury concentrated on the time of N application and showed that nitrogen for seed production was most efficient when applied just after stem elongation had commenced.

Grazing grass-seed crops reduced seed yields because of an indirect negative effect on seedhead size and individual seed weights, both of which proved to be more important than seedhead numbers in determining seed yields.

Key words: Seed production, grasses, plant density, nitrogen, stem elongation, grazing, seedhead size, seed weight.

INTRODUCTION

Our experience with 'Grasslands Tama' Westerwolds ryegrass (*Lolium multiflorum* Lam.), 'Grasslands Nui' perennial ryegrass (*L. perenne* L.), and 'Grasslands Matua' prairie grass (*Bromus willdenowii* Kunth.) has shown that high seed yields do not necessarily come from high density crops but from those containing the largest heads which bear the heaviest seeds (Brown, 1980a, b; Brown, unpublished data). Tillers arising in early autumn have been shown to have larger heads than those arising later in the season, with the maximum number of primary spikelet branches in the head occurring on tillers arising under the flower-inducing conditions of early spring. The number of florets per spikelet can be similarly affected (Ryle, 1966). Tiller order and age, and grazing damage to tillers during vegetative growth, may be of greater consequence in seed production than tiller numbers alone. Factors influencing crop development, including plant density and sowing rate, fertilizer, and grazing management, are the topics discussed in this paper.

PLANT DENSITY AND SOWING RATE

Results from seed production trials in Canterbury have shown significant ($P = 0.05$ or less) and strong negative relationships between plant density (measurement described in Brown, 1980a) and seed yield per plant. Correlation coefficients for three cultivars studied were:

(1) − 0.95 for Tama.
(2) − 0.79 for Nui.
(3) − 0.85 for Matua.

Although the negative effect is modified by factors such as nitrogen, grazing and row spacing, there appears to be a plant density above which high plant numbers fail to compensate for low yields per plant, and below which high yields per plant fail to compensate for low plant numbers. The net result is that seed yields per unit area tend to plateau, with no further gains being obtained by increasing plant density (Table 1). The function of seeding rate is to provide sufficient viable seeds to attain this plant density. Because of seasonal, location, and management variability the "plateau" density may not be constant, but controlled by a range of values. Our results, obtained at various sites in Canterbury, have indicated the following ranges:

(1) Tama 300 to 400 plants/m².
(2) Nui 300 to 400 plants/m².
(3) Matua 100 to 130 plants/m².

TABLE 1: PLANT DENSITY AND SEED YIELDS IN 'GRASSLANDS TAMA' RYEGRASS

*Density** *(plants/m²)*	*Relative Seed Yield*	
	per plant†	*per unit area*
200	100	100
250	87	109
300	77	115
350	68	119
400	60	120
450	53	120
500	47	118

*Covers the original data range.
†Derived from the relationship: seed yield per plant (g) = 1.68 – 0.55 ± 0.07 log plants/m² (r^2 = 0.91).

For seed lines with 90% plus germination and 1000 seed weights of at least 4.5 g, 1.9 g, and 12 g, respectively, these plant densities may be obtained from sowing rates of 15 to 18 kg Tama/ha, 10 to 12 kg Nui/ha, and 20 to 25 kg Matua/ha when drilled at 15 cm row spacing.

FERTILIZER

The use of superphosphate and potassic fertilizers can be of advantage when applied to swards for herbage production, but their value for seed crops is doubtful. Sears (1947, 1950) failed to obtain increased seed yields after applying superphosphate to ryegrass and cocksfoot seed crops, and similar results have recently been obtained with Tama and Nui crops grown in four different Canterbury soils (Brown 1977; 1980b), two of which had low P tests (Ministry of Agriculture & Fisheries Quick Test P = 6) and supported either a Tama or a Nui crop.

Nitrogen is a different proposition because in most cases seed yields are increased regardless of application time. However, the size of the response, and more particularly the efficiency of a given amount of N, can vary according to timing of application. In a 'Grasslands Ariki' hybrid ryegrass (*Lolium* × *hybridum* Hausskn.) trial where the objective was to increase heading and seed yield, nil nitrogen was compared with applications in autumn (April), early spring (August), and in both autumn and early spring, to crops which were vegetative at each application (N rate = 125 kg nitrolime/ha/application). Nitrogen increased head numbers by 30%, but "off the header" yields were only 14% higher irrespective of time of N application. After machine cleaning, seed yields from nitrogen-treated crops were only 7% higher yielding, having dropped from the 14% "off the header" advantage. These results can be explained in terms of reported effects of nitrogen applied to vegetative crops (Langer, 1959; Ryle 1966). These are:

(1) Increased fertility in young, high-order tillers which produce small heads and light seed;

(2) Little or no response by main stem and primary tillers, either vegetatively or in terms of fertility; and

(3) Little or no response by old higher-order tillers in terms of fertility.

In our trial it appears that nitrogen increased the number of fertile, young, high-order tillers, and these produced light seed, a high proportion of which was removed during heading and cleaning. In subsequent trials nitrogen application in spring was delayed until reproductive growth started (when 10% of tillers in a crop showed that stem elongation had commenced). This nitrogen is referred to as "elongation N". Combined results (Brown, 1977, 1980b; Brown, unpublished data) show "elongation N" to be more efficient than N applied at other times (Table 2), and that timing of "elongation N" may vary from season to season, place to place, and possibly between cultivars. In Canterbury, stem elongation usually commences toward the end of September in ryegrass seed crops, but has been observed in mid-May in Southland with 'Grasslands Apanui' cocksfoot (*Dactylis glomerata* L.) and in early September in one crop of Matua prairie grass at Lincoln.

TABLE 2: AVERAGE RESPONSE OF SEED YIELDS TO NITROGEN

Timing of Nitrogen Application	*Mean N Rate (kg/ha)*	*N Response Rel. to No N = 100*	*N Efficiency Rel. to "Elongation N" = 100*
Autumn	35	110	27
Early spring	35	110	27
Autumn + early spring	70	110	13
Elongation	28	130	100
Autumn + elongation	40	125	58

GRAZING

Grazing is thought to be safe until stem elongation commences (Wilson, 1959; Hill, 1970) because young seedheads are below grazing height and there is little chance of their removal by grazing. However, the hooves of grazing animals exert considerable compression and shear forces on the crowns of grass plants and can crush and cut growing points and kill tillers. In many instances the treading action of the grazing animal may be beneficial to subsequent pasture production (Brown, 1968a, b, 1971; Brown and Evans, 1973), but when a crop is used for seed production treading damage may have a permanent detrimental effect on seed yield by removing many of the tillers capable of producing large heads and heavy seeds. Another, and usually the most obvious, grazing effect is defoliation. It reduces the size of tiller growing points and consequently the number of sites where leaf buds can form (Forde, 1966). In a reproductive tiller the growing point becomes the main axis of the developing seedhead and branching occurs at sites where leaf buds join the growing point. Thus defoliation during vegetative growth may reduce the size of seedheads produced by surviving old tillers. Work at Lincoln has compared grazed and ungrazed crops and has shown that grazed crops did not produce any more heads than ungrazed crops although having higher tiller densities. Grazed crops also produced smaller heads and lighter seeds which became significant contributors to greater processing losses in these crops, particularly at the seed-cleaning stage and in Tama (Brown, 1980a: Table 3). These effects accumulated into large differences favouring ungrazed over grazed crops and, for two successive Nui crops off the one stand, were large enough to result in the financial returns from ungrazed crops being 25% higher than those of seed plus grazing from grazed crops. Although grazing grass seed crops during the so-called "safe peiod" may not be as safe as was thought, lodging is a problem more likely to affect ungrazed crops and may be more harmful to seed production than grazing. Usually lodging is brought about by over-vigorous growth in tall stands and may even occur before head emergence. One way to overcome the problem, and also be in a position to capitalize on the advantages made possible by not grazing, is to restrict vegetative growth by withholding fertilizer, particularly nitrogen, during the vegetative period.

TABLE 3: UNGRAZED SEED CROPS RELATIVE TO GRAZED CROPS = 100

Yield Component	*Tama*	*Nui*
Seedheads	100	106
Spikelets/head	118	111
Florets/spikelet	105	110
Seed recovery*	137	111
Seed yield	170	144

*Seeds/100 florets after machine dressing.

GENERAL COMMENTS

Our work in Canterbury indicates that yields of machine-dressed seed are positively related to the following factors in order of decreasing importance:

(1) Seedhead size (number of florets per head).

(2) Individual seed weight (heavier seeds will not be lost during heading and seed cleaning).

(3) Number of seedheads.

This result means that highest-yielding crops are not always those with most heads, but are those with large heads producing heavy seeds, *i.e.*, crops with a high proportion of low-order tillers formed in autumn and winter.

REFERENCES

Brown, K. R., 1968a. *N.Z. Jl agric. Res.*, *11*: 131-7.
——— 1968b. *Ibid.*, *11*: 883-90.
——— 1971. *Ibid.*, *14*: 828-34.
——— 1977. *N.Z. Jl exp. Agric.*, 5: 215-8.
——— 1980a. *Ibid.*, 8.
——— 1980b. *Ibid.*, 8.
Brown, K. R.; Evans, P. S., 1973. *Ibid.*, *1*: 217-26.
Forde, B. J., 1966. *N.Z. Jl Bot.*, *4*: 469-78.
Hill, M. J., 1970. *N.Z. Jl Agric.*, *121* (Nov.): 52-4.
Langer, R. H. M., 1959. *Ann. appl. Biol.*, *47* (4): 740-51.
Ryle, G. J. A., 1966. In *The Growth of Cereals and Grasses*. Butterworths, London, 359 pp.
Sears, P. D., 1947. *N.Z. Jl Agric.*, *75*: 229-34.
——— 1950. *Ibid.*, *80*: 379-84.
Wilson, J. R., 1959. *N.Z. Jl agric. Res.*, *2*: 915-32.