Production problems facing the herbage seed industry in New Zealand with particular reference to ryegrass (*Lolium* spp.)

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Abstract

In New Zealand, production of herbage seed involves 35,350 ha, and is dominated by two species; ryegrass (*Lolium* spp.) and white clover (*Trifolium repens*). Profitability is primarily determined by seed yield, while market access is determined by seed quality. Average ryegrass seed yields range from 1030–1280 kg/ha, while the highest yielding crops average 2015-2210 kg/ha. Factors affecting seed yield include weed competition, nitrogen, moisture stress, disease management and late season frosts. Each of these points is discussed in this paper, with examples. Wild oats (*Avena fatua*) are very competitive and can reduce seed yields by 0.35 kg/ha for each 1.0 kg dry matter of wild oat. Seed yields are strongly determined by foliar N concentration at stem elongation. Azoxystrobin fungicide increased seed yields by 52%, compared to a 20% increase in yield for tebuconazole, the fungicide most commonly used by growers, when compared with non-treated control yields. Seed quality is determined by germination percentage and seed purity (freedom from weed seeds). Variation in germination is commonly associated with blind seed disease caused by *Gloeotina temulenta*. Partial control of blind seed disease with fungicides resulted in an increase in germination by 10 %.

***Additional key words:** seed yield, seed quality, white clover, wild oat, azoxystrobin, strobilurin*

Introduction

Herbage seed production in New Zealand involves 35,350 ha, with ryegrass (*Lolium* spp.) (56 % of land area) and white clover (*Trifolium repens*) (33 % of land area) the predominant species (Anon., 1998). Twenty other species are grown on the remaining 11 %, including red clover (*Trifolium pratense*), tall fescue (*Festuca arundinacea*), cocksfoot (*Dactylis glomerata*) and browntop (*Agrostis capillaris*). This review reports results from ryegrass seed production research to illustrate production problems facing the herbage seed industry. These problems can be grouped as those affecting either seed yield and/or seed quality. Profitability for growers is largely determined by seed yield, while market access is often determined by seed quality, especially freedom from specific weeds and a high germination percentage. High and low yielding crops often have similar inputs, and therefore similar production cost (Rolston and McCloy, 1997). Seed yields of the top ten perennial and hybrid (*L. x boucheanum*) ryegrass seed crops in the annual Ryegrass 2000 Awards programme (Rolston, 1995) have averaged from 2015 to 2210 kg/ha, compared with the national average seed yield of 1030 to 1280

Table 1. Perennial and hybrid ryegrass seed yields compared with the national average and total number of crops entered for certification.

Year	Yield Top 10 Crops[1]	No. Crops >2000 kg/ha[1]	Highest Yield[1] kg/ha	Average Yield[2] kg/ha	Number of Crops[2]
1994/95	2015	3	2620	1070	1245
1995/96	2000	4	2260	1280	1516
1996/97	2210	17	2310	1030	1585
1997/98	2100	7	2410	N/A	1944

[1]Data based on entries to the annual Ryegrass 2000 Awards
[2]Based on MAF Seed Certification figures adjusted for 10% of crops entered for certification failing field inspection or laboratory testing.

kg/ha in the same period (Table 1). Germination of ryegrass seed crops varies from year to year, with the percentage of seed lots achieving 90-100 % germination ranging from 48 % to 90 % (Table 2).

Weed Contamination and Competition

Trends in weed seed contamination have been reported by Rowarth *et al.* (1993). Weed seeds will devalue a seed lot, and may contain prohibited species, e.g., wild oats (*Avena fatua*), or undesirable species, e.g., docks (*Rumex* sp.). Seed for the USA market must be free of field pansy (*Viola arvensis*), while turf seed contracts specify nil or very low levels of annual poa (*Poa annua*). Herbicides to control these weeds have become available in recent years, including fenoxyprop-P-ethyl (Trade name: Puma S) for wild oat control in grass seed crops; diflufenican (Trade name: Jaguar) for field pansy control in grasses and white clover, and ethofumesate (Trade name: Nortron) for annual poa control in most grass species.

Weed species are very competitive against slow establishing grass species including browntop, cocksfoot and phalaris (Rolston and Hare, 1986). In ryegrass, the presence of annual poa (*Poa annua*) reduced seed yields by 40 % in a low yielding crop, while wild oats reduced seed yields from 2620 to 650 kg/ha in a high yielding crop (Fig. 1) (Rolston and Archie, 1999).

Disease and Fungicide Responses

Blind seed disease in ryegrass is caused by the f\ungus Gloeotina temulenta. An epidemic of blind seed disease occurred in the upper Canterbury plains (e.g., Methven area), which is a significant area for seed production, in 1993 and 1994, resulting in nearly half the seed lots failing to achieve 90 % germination (Table 2).

Table 2. Percentage of the ryegrass seed crop occurring in different germination classes (from National Seed Testing Laboratory, Palmerston North, New Zealand).

	Germination Classes		
Year	90-100%	85-89%	‹85%
1993	54	19	27
1994	48	19	33
1995	79	9	12
1996	90	7	3
1997	76	13	11

Research has shown that both seed treatment with benomyl and foliar fungicide application at flowering with tebuconazole (Trade name: Folicur) and carbendazim reduces blind seed disease (Fig. 2) and increases perennial ryegrass germination (Rolston and Falloon, 1998).

Stem rust (*Puccinia graminis*) is also a serious disease in ryegrass causing seed yield losses of up to 80 %

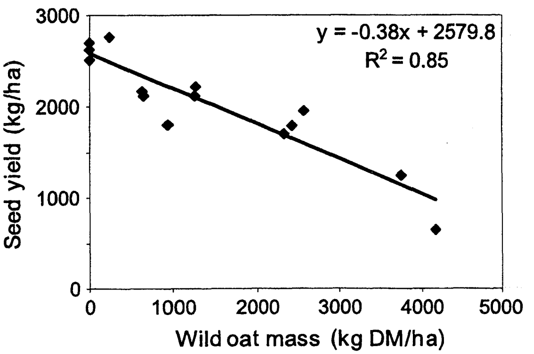

Figure 1. Competition effects of wild oat on seed yield of perennial ryegrass. Each data point is the mean of three replicates.

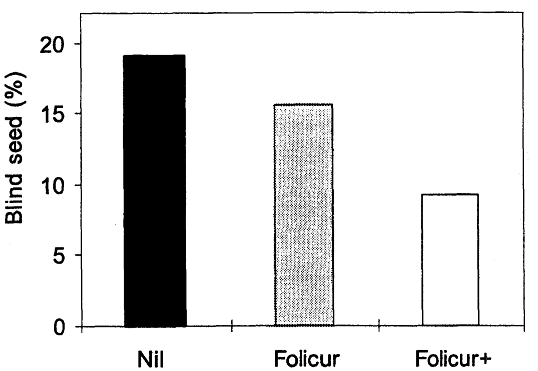

Figure 2. Fungicide effects on blind seed disease in perennial ryegrass (cv Embassy) with fungicides: tebuconazole (Folicur) and a sequential application of tebuconazole + carbendazim (Folicur +). Means are an average of four years data

Table 3. Fungicide effects on disease, green leaf area (GLA) and seed yield of Grasslands Impact hybrid ryegrass in 1996/97.

Fungicide	Stem rust (% stems with rust)	GLA (%)	Seed yield (kg/ha)
Nil	44	34	1220
tebuconazole[1]	5	51	1470
tebuconazole +carbendazim[2]	5	56	1570
azoxystrobin[3]	1	53	1850

[1]tebuconazole (Folicur) at 100 +190 g active ingredient (ai)/ha, applied 8 November, 9 December 1996.
[2]tebuconazole as in 1, + carbendazim at 250 g ai/ha applied 23 December 1996.
[3]azoxystrobin (Amistar) at 250 + 250 g ai/ha, applied 8 November, 9 December 1996.

(Kerse and Ballard, 1989). Stem rust has become a major problem for growers multiplying USA turf cultivars. These cultivars are later flowering than most New Zealand bred forage cultivars and more susceptible to the stem rust strains that occur in New Zealand. The new strobilurin fungicide, azoxystrobin (Trade name: Amistar) increased seed yields by 52 %, while the standard triazole fungicide treatment increased yield by 20 % when compared with non-treated control yields (Table 3). In another trial, azoxystrobin increased seed yield in perennial ryegrass by 35 % (Rolston, unpublished) compared to a standard triazole fungicide control.

Nitrogen

Nitrogen (N) usage in grass seed crops has increased significantly in recent years. Earlier research trials reviewed by Rolston *et al.* (1985) used rates from 60 to 120 kg N/ha. typical of inputs used at the time. In the mid 1990s, rates of 180 kg N/ha were in common use (Rolston and McCloy, 1997). Rowarth *et al.* (1998, 1999) demonstrated that seed yields were strongly related to foliar N levels at the beginning of stem elongation. The response of a late flowering hybrid ryegrass to increased rates of N (Figs. 3 and 4) is typical of the responses observed by Rowarth for perennial ryegrass,

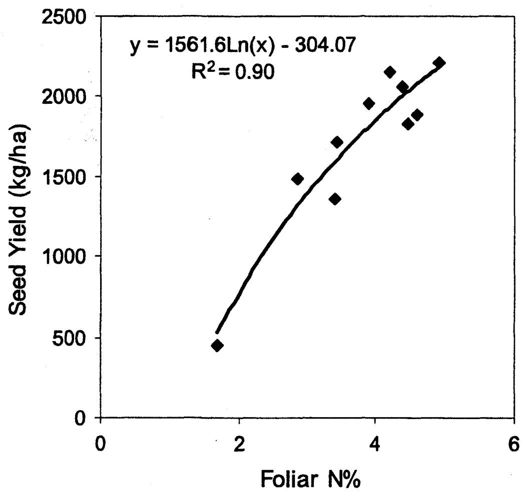

Figure 3. Relationship between seed yield of hybrid ryegrass and foliar N% at 25 September 1996 (double ridge-early stem elongation growth stage).

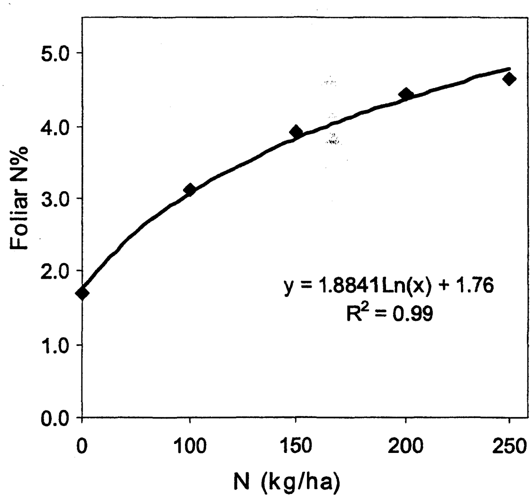

Figure 4. Relationship between N applied and foliar N at 25 September 1996 (early stem elongation) in Grasslands Impact hybrid ryegrass.

where maximum seed yields are obtained when foliar N % is above 4.5 % at the onset of the reproductive growth phase.

Moisture Stress and Irrigation

Approximately half of the New Zealand herbage seed crop is grown with irrigation. In tall fescue (cv Grasslands Advance) average seed yields over three seasons for crops grown with irrigation were between 52 % and 65 % higher than for dryland crops. In perennial ryegrass, nitrogen responses were lower on a dryland site compared to irrigated plots (Fig. 5), and irrigation increased seed yields (Rolston *et al.*, 1994). The crop growth stage when water stress occurs is important, with stem elongation and anthesis being very sensitive (Rowarth *et al.*, 1997).

Frosts

Late spring frosts occur from mid-November to mid-December (head emergence to seed maturation) in two out of three years in the upper Canterbury plains. Frost events are commonly associated with drought years and quantifying frost effects in the field is difficult. Thus quantifying frost effect usually involves controlled conditions in a frost chamber. Using such chambers, Hare (1995) demonstrated large yield losses in tall fescue

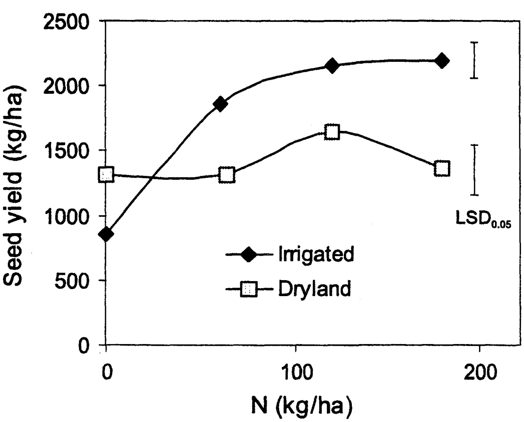

Figure 5. Seed yield response of perennial ryegrasss (cv. Grasslands Nui) to irrigation and applied N (from Rolston *et al.* 1994). Data points are means of four replicates.

frosted at −2 °C. However seed growers are in no doubt about the losses they sustain from frosts, and insurance claims for frost losses became so frequent during 1996-98 that companies stopped offering frost insurance on ryegrass from 1999 (Canterbury Assessors, *pers. comm*). In that period, 10 frost events were recorded and frost temperature profiles based on 15 minute recording intervals were developed. Frosts commonly last for 2 hours, have a maximum of 6 hours, with a slow temperature draw-down phase, and a rapid temperature rise at dawn. Frosts of −2.3 °C have been recorded at Methven, and are associated with spikelet bleaching, and seed yields below average. Frost damage is often associated with early lodging, particularly if patches lodge that trap cold air. Plant growth regulators that reduce lodging may be useful as frost avoidance tools.

Conclusion

In the last decade considerable progress has been made in applied herbage seed production research in New Zealand, with solutions being adopted that are lifting the seed yields of the best seed growers. Research in seed production has been strongly focused on components (e.g., nitrogen) without studying the interaction of all components in a systems approach. Problems still exist, including the management of late season frosts, and the integrating of a range of inputs to maximize per unit area profit, and this will probably be associated with maximizing seed yield and quality. In particular there is a need to understand the relationships between high N inputs, low sowing rates, late autumn sowing dates, irrigation, lodging pre-flowering and the interaction of these factors with new plant growth regulators (e.g., trinexapac-ethyl) that reduce lodging.

Improving the genetic potential for seed yield in grass seed crops without compromising forage and turf qualities is a challenge for researchers looking for the next step towards increasing seed yields. Our current research indicates that it is possible to increase seed yield in ryegrass and tall fescue through breeding.

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