Yield Components of the Perennial Ryegrass (*Lolium perenne* L.) Seed Crop [1]

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ABSTRACT

Variance in seed yield of perennial ryegrass (*Lolium perenne* L.) cv. S.24 at Sutton Bonington, Leics., U.K. between 1971-1980 was best explained by the number of seeds per unit area. In lodged crops, seed numbers were dependent on the number of seeds per spikelet, and were only poorly related to the number of fertile tillers present at final harvest. In non-lodged crops, however, both the number of seeds per spikelet and the number of fertile tillers per unit area were positively and significantly related to seed numbers. Neither spikelets per tiller or thousand seed weight was significantly correlated with seed number or yield.

Most perennial ryegrass seeds crops in U.K. are lodged at or before anthesis. Providing fertile tiller numbers are not limiting (*i.e.* are between 2000-4000 m^{-2}), then seed numbers and hence yield depend primarily on conditions governing the number of seeds set per spikelet.

Additional index words: **lodging, seed numbers, spikelets, fertile tillers.**

INTRODUCTION

The seed yield of *Lolium perenne* L., like that of wheat and other cereals, (Gallagher, Biscoe and Scott, 1975) depends primarily on the number of seeds produced per unit area (Hebblethwaite, Hampton and McLaren, 1982). Recent data for perennial ryegrass cv. S.23 and S.24 has shown that seed number per unit area accounted for 60-98% of yield variance (Hebblethwaite and Hampton, 1982).

The yield components which constitute seed number are fertile tillers per unit area, spikelets per fertile tiller, and seeds per spikelet. Langer (1980), suggested that seed numbers, and hence seed yield depended primarily on the number of fertile tillers per unit area, as both Field-Dodgson (1971) and Spiertz and Ellen (1972) found highly significant correlations between fertile tiller population and seed yield. However, Hebblethwaite and Hampton (1982) suggested that once fertile tiller numbers had reached around 2000 m^{-2}, increasing tiller numbers had little effect on either seed numbers or yield up to around 4000 fertile tillers m^{-2} .

This paper discusses some of the factors affecting seed number and hence seed yield in perennial ryegrass cv. S.24. The data are drawn from a series of experiments carried out at the University of Nottingham School of Agriculture, Sutton Bonington, Loughborough, Leicestershire, U.K., between 1971-1980 (Hebblethwaite, Wright and Noble, 1980; Hebblethwaite and Hampton, 1982).

MATERIALS AND METHODS

The relationship between seed numbers and yield components was examined using regression analysis on data from 20 experiments where the crop had lodged at or before anthesis, and 10 experiments where, either by mechanical (Hebblethwaite, Burbidge and Wright, 1978) or chemical methods (Hebblethwaite, Hampton and McLaren, 1982), lodging was prevented.

RESULTS

In lodged crops, fertile tiller numbers were not significantly related to seed numbers (Table 1), but in non-lodged crops, fertile tiller numbers accounted for 75% of the variance in seed number m^{-2} . In both lodged and non-lodged crops, seeds per spikelet were significantly correlated with seed number (Table 2), whereas the relationship between spikelets per tiller and seed number was negative and not significant (r = -0.264 and -0.607 for lodged and non-lodged crops respectively). At Sutton Bonington, thousand seed weight (TSW) of perennial ryegrass cv. S.24 varied from 1.56 - 2.18 g over the 10 years, but was not significantly related to seed number or yield.

DISCUSSION

In lodged perennial ryegrass seed crops between 1971-1981, fertile tiller numbers were not significantly related to seed numbers or to seed yield (Hebblethwaite and Hampton, 1982). This conflicts with the results of Field-Dodgson (1971) and Spiertz and Ellen (1972). At Sutton Bonington, management practices stayed relatively constant over the 10 years in terms of sowing time, rate, amount of nitrogen, phosphate and potassium applied (Hebblethwaite, Burbidge and Wright, 1978; Hebblethwaite and Ivins, 1978; Wright and Hebblethwaite, 1979; Hebblethwaite, Hampton and

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Table 1. Relationship between seed number m^{-2} (Y) and fertile tiller number m^{-2} (X) in lodged and non-lodged perennial ryegrass (cv. S.24) crops, 1971-80.

Relationship showing best fit	Significance	% variance accounted for:	data range	
lodged (d.f = 18) $Y = 5.47(\pm 2.02)+0.0003(\pm 0.0007)X$	NS	-5.2	seeds m^{-2} x 10^4 :	3.5 - 10.5
			fertile tillers m^{-2} :	1338 - 3865
non-lodged (d.f = 8) $Y = 1.01(\pm 0.52)+0.002(\pm 0.001)X$	**	73.7	seeds m^{-2} x 10^4:	5.5 - 16.3
			fertile tillers m^{-2} :	1540 - 4049

Table 2. Relationship between seed number m^{-2} (Y) and seeds per spikelet (X) in lodged and non-lodged perennial ryegrass (cv. S.24) crops, 1971-80.

Relationship showing best fit	Significance	% variance accounted for:	data range	
lodged (d.f = 18) $Y = 2.46(\pm 0.79)+2.69(\pm 0.52)$	**	59.8	seeds m^{-2} x 10^4 :	3.5 - 10.5
			seeds per spikelet:	0.76 - 2.50
non-lodged (d.f = 8) $Y = 2.78(\pm 0.24)+3.82(\pm 1.10)$	**	55.1	seeds m^{-2} x 10^4:	5.5 - 16.3
			seeds per spikelet:	0.99 - 3.39

McLaren, 1982), so that the environment provided the biggest effects on seed yield and its components. In contrast, Field-Dodgson (1971) obtained greater seed yields through the production of more fertile tillers in response to nitrogen application, while Spiertz and Ellen (1972) achieved the same result through manipulation of light intensities in the spring. In both cases, overcoming deficiencies in the crop through the application of nitrogen and more light respectively provided the linear relationship between fertile tiller numbers and yield. Spiertz and Ellen (1972) also found that when light intensities were changed in autumn, the relationship between fertile tiller numbers and seed yield was negative and non-significant, because restricted autumn tiller development produced a flush of low yielding spring-formed fertile tillers.

Fertile tiller numbers may be decreased in lodged crops through rotting of the base of the stem in a wet year (Burbidge, 1977), but in 6 of the 10 experiments, fertile tiller numbers were not significantly different at final harvest in lodged and non-lodged crops.

In non-lodged crops, fertile tiller numbers were significantly related to seed number, but not to seed yield (Hebblethwaite and Hampton, 1982), because although seeds per spikelet did not change significantly, spikelets per tiller decreased significantly with increasing fertile tiller numbers (Hampton, unpub. data).

In both lodged and non-lodged crops, spikelets per tiller were not significantly related to seed number. The number of spikelets per tiller is dependent on the number of reproductive primordia accumulated at the shoot apex at the onset of reproductive development in the spring, and on the number of additional primordia delimited during apical development (Ryle, 1964). Factors affecting spikelet number per tiller have been recently discussed (Hebblethwaite, Wright and Noble, 1980).

Langer and Lambert (1963) noted that in grass, TSW appeared remarkably uniform. Although affected by the age of tillers (Anslow, 1964), timing of nitrogen (Hebblethwaite and Ivins, 1978) and irrigation (Wright, 1978), variation in TSW from season to season, which was not related to seed number or yield, is possibly best explained through the flexibility of the ryegrass plant in its adjustment of the yield components in response to various environmental factors. Thus in some seasons, seed number explained over 95% of the seed yield variation (Hebblethwaite and Hampton, 1982) while in others, TSW also had a limited influence.

Lodging occurs in most perennial ryegrass seed crops grown in U.K. Providing fertile tiller numbers are not a limiting factor (because of poor establishment, moisture stress or a shortage of nitrogen), then it appears that seed numbers are determined primarily by conditions governing the number of seeds per spikelet (Hill, 1980), and not by fertile tiller number.

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