The Effects of the Environment at Anthesis on the Seed Yield and Yield Components of Perennial Ryegrass (*Lolium perenne* L.) cv. S.24. [1]

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ABSTRACT

An examination of macro-environmental factors during anthesis of perennial ryegrass (*Lolium perenne* L.) cv. S.24 seed crops at Sutton Bonington, UK over the period 1971-80 showed that minimum screen temperature (C) accounted for 70% of the variance in seed numbers recorded. Wind velocity in the week following peak anthesis and rainfall during the week of peak anthesis were significantly related to seed number and yield respectively. Further work should determine the effects of the micro-environment at anthesis on seed number and yield.

Additional index words: Temperature, wind, velocity, rainfall.

INTRODUCTION

Hampton and Hebblethwaite (1983) have shown that in perennial ryegrass seed crops which lodge either before or during anthesis, seed number, and hence seed yield is dependent largely on the number of seeds per spikelet and not the number of fertile tillers. Final seed yield is often less than one-tenth of the theoretical potential seed yield (Hebblethwaite, Wright and Noble, 1980). The maximum number of seeds per spikelet is determined shortly before ear emergence, by which time the number of florets has been fixed. The subsequent events of anthesis, pollination and fertilization follow to determine the seed-set component of the total yield. Hill (1980) recently reviewed the effects of environmental conditions over this period on seed yield in perennial ryegrasses. In this paper, we have examined the effects of climate at anthesis on seeds per spikelet, seed number and seed yield of perennial ryegrass cv. S.24 at Sutton Bonington over a 10 year period.

MATERIALS AND METHODS

Seed yield and component data were drawn from the same series of experiments described by Hampton and Hebblethwaite (1983), carried out at the University of Nottingham, School of Agriculture, Sutton Bonington, Loughborough, Leics., UK between 1971-80. Meterological data were obtained from records for the years 1971-80 (Reports, School of Agriculture, University of Nottingham 1970/71-1976/79; unpub. data). Data for minimum, maximum and mean screen temperature (C), daily wind run (km h^{-1}), rainfall (mm), sunshine (h), mean daily radiation (MJ m^{-2}) and relative humidity, for the month of June (during which anthesis occurs in perennial ryegrass cv. S.24), the week of peak anthesis (usually the third week of June — peak anthesis was recorded from 11-23 June over the 10 years), and the week following peak anthesis was used. Meteorological data were recorded from a site which was always within 1 km of experimental plots, and the range of data recorded is presented in Table 1. Yield data were taken from control (i.e. lodged) plots over the 10 years.

RESULTS

Minimum screen temperature was significantly and positively correlated with seed number and yield at all three time periods (Table 2) and with seeds per spikelet at and after anthesis. This one factor accounted for over 70% of the variance in seed numbers recorded. Some of the variations in the data recorded are presented in Table 3. The only other factor significantly related to seed number was wind velocity in the week following anthesis (Table 2) where seed numbers were reduced by increasing wind velocity.

Rainfall during the week of peak anthesis significantly affected seed yield (Table 2), but not seed numbers or seeds per spikelet. Mean daily radiation, sunshine, and relative humidity were not significantly related to either yield or its components.

DISCUSSION

This examination of the effects of macro-environmental changes on seeds per spikelet, seed number and yield, although accurate, was crude in relation to the micro-environment within the crop. However, it has been adequate to highlight the importance of low temperature in determining seed numbers at this location. Low temperatures are known to slow down or even inhibit anthesis in perennial ryegrass (Jones and Brown, 1951; Hill, 1980), and Hill (1971) found that low night temperatures decreased flowering intensity and reduced the number of florets open at peak anthesis. Emecz (1961) found that a threshold level of 14 C was required before anthesis would begin in perennial ryegrass cv. S.24. Wheat plants are known to be most susceptible to damage by low temperature when they are at the point of anthesis (Olugbemi, 1968), because at

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Table 1. Range of meteorological data associated with seed number, yield and seeds per spikelet in perennial ryegrass cv. S.24, Sutton Bonington, 1971-80.

	Month of June			Week of peak anthesis			Week after peak anthesis		
	min.		max.	min.		max.	min.		max.
Min. screen temp. (C)	7.7	-	9.9	7.8	-	10.0	8.0	-	10.2
Max. screen temp. (C)	15.7	-	23.2	15.2	-	22.8	15.5	-	24.1
Mean screen temp. (C)	11.9	-	17.0	11.1	-	15.7	11.8	-	16.1
Windrun (km h^{-1})	7.2	-	9.9	6.5	-	10.9	5.1	-	10.1
Sunshine (h)	122	-	229	24.5	-	52.9	15.9	-	52.8
Rainfall (mm)	10	-	109	0.1	-	44.7	1.7	-	23.8

Table 2. Relationship between environmental factors during June; week of peak anthesis; week after peak anthesis, and a) seeds m^{-2}, b) seed yield, c) seeds per spikelet.

	Month of June	Week of peak anthesis	Week after peak anthesis
a) *Seed number*			
Min. screen temp. (C)	0.871**[1]	0.872**	0.842**
Windrun (km h^{-1})	-0.467	0.109	-0.644*
Sunshine (h)	0.361	0.566	0.499
Rainfall (mm)	0.356	0.287	0.076
Relative humidity	-0.453	0.327	-0.030
Mean daily radiation (MJ m^{-2})	-0.450	-0.195	-0.207
b) *Seed yield*			
Min. screen temp. (C)	0.737*	0.627*	0.629*
Windrun (km h^{-1})	-0.322	0.251	-0.387
Sunshine (h)	0.176	0.144	0.342
Rainfall (mm)	0.603	0.666*	0.118
Relative humidity	-0.423	-0.121	-0.320
Mean daily radiation (MJ m^{-2})	-0.416	-0.324	-0.254
c) *Seeds per Spikelet*			
Min. screen temp. (C)	0.456	0.749*	0.806**
Windrun (km h^{-1})	0.469	0.567	-0.501
Sunshine (h)	0.443	0.516	0.596
Rainfall (mm)	0.017	0.117	-0.259
Relative humidity	-0.317	0.295	0.381
Mean daily radiation (MJ m^{-2})	-0.404	-0.506	-0.457

[1] correlation between data sets d.f. = 8

this stage the reproductive organs are fully developed and therefore most susceptible to temperature stress (Hill, 1980). Temperature may also affect processes after anthesis. Hill (1971) found that a 2 C frost during the first few days of seed development reduced seed set in perennial ryegrass.

Wind velocity was the only other factor found to significantly affect seed number. Wind velocity is important in hindering or even inhibiting anthesis in a range of grasses (Hill, 1980). A velocity of 28 km h^{-1} inhibits anthesis in perennial ryegrass cv. S.24 (Emecz, 1961) although velocities recorded in this study were only between 5-10 km h^{-1}.

Hill (1980) has reviewed the effects of rainfall, light intensity and relative humidity on ear development in grasses, and all have been shown to influence anthesis (Smith, 1944; Emecz, 1961; Hill, 1971; Vough, 1975). In this study, none of these factors were significantly related to seed numbers or seeds per spikelet, although rainfall during the week of peak anthesis significantly increased seed yield. However, this was probably linked to events after anthesis, through a reduction in soil moisture deficits. It is evident that further work is required to determine the relative importance of these climatic factors in the micro-environment of the crop, and their interactive relationship with yield.

Table 3. Variations in temperature at anthesis and seed number and yield, perennial ryegrass cv. S.24, Sutton Bonington.

Seed number	Seed yield	Mean screen temperature, (C) June			Year
(m^{-2} x 10^4)	(t ha^{-1})	(Min.)	(Max.)	(Mean)	
3.48	0.69	7.8	16.7	12.3	1977
4.16	0.98	7.7	16.7	12.2	1972
6.37	1.24	9.6	18.1	13.8	1980
8.66	1.33	9.9	19.6	14.8	1973

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