Methods for Estimating Seed Production of Two Summer-Active Grass Weeds, *Setaria pumila* and *Digitaria sanguinalis*, in New Zealand Dairy Pastures

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Introduction

Undesirable C4 annual grasses such as summer grass (Digitaria sanguinalis, (L.) Scop., SG) and yellow bristle grass (Setaria pumila (Poir.) Roem. et Schult., YBG) are prevalent in dairying regions in the North Island of New Zealand. Field surveys of 39 dairy pastures in the central North Island demonstrated that their percentage ground cover has tripled over the last four years (Tozer et al. 2012). The prolific seed production of these species is thought be facilitating this increase in ground cover. However, little information is available on their fecundity in dairy pastures. Counting the number of seeds in a panicle is slow and laborious, therefore a rapid and robust method to assess fecundity is required. In USA crops, Forcella et al. (2000) found a significant curvilinear relationship between YBG seeds per panicle and panicle length, regardless of crop identity, year and weed density. A study was therefore established to determine if panicle length or weight could be used to estimate YBG and SG fecundity in intensively managed dairy pastures in New Zealand.

Methods

In March 2011, five paddocks containing YBG and SG were randomly selected on four dairy farms, near Ohaupo, in the central North Island of New Zealand. Within each paddock, 20 panicles of each species were randomly selected. For YBG, the number of seeds, the panicle length from the lowest to the highest seed, and panicle weight were recorded for each spike-like panicle. For SG, whose panicle comprises two or more racemes (arms) that arise from near the end of the flowering stem (Edgar and Connor 2000), the number of seeds, panicle length (sum of the raceme lengths) and panicle weight were recorded. Additionally, 20 panicles were randomly selected within each paddock to obtain the 100 seed-weight for each species. Only mature seeds were included; unripe or unviable seeds were discarded (*i.e*. seeds which were soft to handle or pale in colour).

The number of seeds per panicle and seed weight were analysed by split-plot ANOVA, with paddock and species as factors. Data did not require transformation to normalise the variance. A linear regression was undertaken for panicle length, and for panicle weight, on the number of seeds per panicle for each species.

Results

Differences between species were highly significant for panicle weight, seeds per panicle, panicle length and seed weight (P<0.001, Table 1). Based on species averages: 1) the total length of the SG panicle (summing all racemes) was 478 mm, in comparison to 35 mm for YBG; 2) YBG panicles were over twice the weight but produced under half the number of seeds - SG produced 186 seeds per panicle while YBG only produced 90; and 3) YBG seeds were four times as heavy as SG seeds.

Variation between sites (paddocks) was significant (Table 1) for panicle weight, seeds per panicle and panicle length (all P<0.001), but not for seed weight (P>0.05), which was similar across sites. The variation between sites was often large; seeds per panicle ranged from 102 to 285 for summer grass and from 57 to 119 for YBG.

There was a significant regression, for each species, between the number of seeds per panicle and panicle length and the number of seeds per panicle and panicle weight

Table 1. YBG and summer grass panicle weight (mg), seeds per panicle, panicle length (mm) (averaged over 20 panicles from each site) and 100 seed weight (mg), for summer grass and yellow bristle grass in each of 5 sites (dairy pastures).The sed is for comparisons between the two annual grasses at the same site. All site, species and site by species effects were significant at *P*<0.001 for all measurements, except for site seed weight where *P*=0.065

Measurement	Summer grass						YBG						Sed
	1	2	3	4	5	Avg	1	2	3	4	5	Avg	
Panicle length (mm)	183	336	214	321	478	306	30	34	23	44	42	35	29.3
Panicle wt (mg)	40	91	39	73	112	71	95	204	45	186	273	161	26.5
Seeds per panicle	102	233	121	191	285	186	82	99	57	93	119	90	20.2
Seed weight (mg)	650	678	522	605	645	620	2389	2435	2546	2312	2271	2390	43.1

(*P*<0.001), with the best fit from a common slope with different intercepts for each paddock:

- Summer grass seeds per panicle increased by 1.53 ± 0.13 with each 1 mg extra panicle weight, adj R^2 = 76.2;
- Summer grass seeds per panicle increased by 0.57 ± 0.03 with each 1 mm extra panicle length, adj R^2 = 88.8;
- YBG seeds per panicle increased by 0.35 ± 0.02 with each 1 mg extra panicle weight, adj R^2 = 82.9;
- YBG seeds per panicle increased by 2.73 ± 0.15 with each 1 mm extra panicle length, adj R^2 = 81.9.

Panicle length was the best predictor of increase in seeds per panicle for summer grass (adj R^2 = 88.8) and panicle weight was the best predictor for YBG (adj R^2 = 82.9).

Discussion and Conclusion

The strong correlation between seeds per panicle and panicle length or panicle weight, for both YBG and summer grass in dairy pastures, increases confidence in estimates of fecundity based on panicle weight or length. Further, the strength of this relationship demonstrates how accurate and rapid estimates of seed production can be made under field or controlled conditions, even given the huge morphological variation in populations that occurs between paddocks. While both predictors are highly correlated, we recommend using panicle length - as discussed by Forcella et al. (2000), panicle length measurements can be taken before, during or after seeds are dispersed. Length estimates can then be multiplied by an estimate of panicle numbers in a given unit of area, to rapidly obtain an estimate in the change in total seed production. This reduces the need for time-consuming dissections and seed counting in the laboratory. This information will be useful for quantifying propagule pressure and assessing the effectiveness of control strategies in reducing seed production in dairy pastures.

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