SEED PRODUCTION CHARACTERISTICS OF *DICHANTHIUM SERICEUM, HETEROPOGON CONTORTUS* AND *THEMEDA TRIANDRA* ECOTYPES UNDER INTENSIVE MANAGEMENT SYSTEMS IN NORTH QUEENSLAND.

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INTRODUCTION

Increasing demand for seed of native grasses in Queensland, mostly for rehabilitation of landscapes affected by mining or urban development, is not being satisfied through current production systems. Most native grass seed is harvested from wild stands. Although guidelines have been developed for the production of wild-harvested seed (Waters *et al*. 2000), seed is often of inconsistent supply, expensive and of poor planting value (Waters *et al*. 1997). As a result, exotic grasses are often substituted for native grasses because of the shortfall of affordable and good quality seed.

The tropical native grass seed industry is poorly developed compared to the introduced tropical grass seeds industry based in north Queensland. The fragmented state of the industry is considered the key limitation to development of the native grass seeds industry in Australia (Waters *et* al. 1997). With no significant development, the immediate value of the tropical native grass seeds market for mining and road development in Queensland is estimated at $100 000 per annum, but this is expected to increase markedly should less expensive and higher quality seed become available (Chivers, *pers. comm.*). Market roles include revegetation, low maintenance plants for amenity and horticultural systems and as pasture, particularly in infertile and dry areas (Chivers 2003).

Inexpensive and high quality seeds of introduced tropical and sub-tropical grasses are produced by specialist growers on the Atherton Tableland, north Queensland, under intensive production systems. This approach is successful in southern Australia to produce seeds of southern ecotypes of native grasses but has yet to be appraised in northern Australia. A 4 year study was begun in 2005 to assess the seed production performance of 70 ecotypes of *Dichanthium sericeum* (A. Camus), *Heteropogon contortus* (P. Beauv.) and *Themeda triandra* (Forssk.) on the Atherton Tablelands under intensive management. The performance of 24 selected accessions in replicated trials is reported here.

METHOD

Mature seed of ecotypes of *T. triandra*, *H. contortus* and *D. sericeum* were collected from natural grass communities in coastal and sub-coastal areas between north Queensland and northern New South Wales during 2005-2006 (Table 1) to provide a range of collection environments. Assessment of seed production performance under replication was undertaken at two sites representative of those used for seed production on the Atherton Tablelands (17.2S, 145.4ºE). Sites provided contrasting soils and micro-climates within an elevated tropical monsoonal environment: Walkamin - basalt-derived soils and affected by cloudy conditions during autumn; Southedge - granite-derived soils with little autumn cloud. Two replicates were planted at each site using a randomised complete block design.

Plants were raised under controlled conditions and transplanted using even plant spacing into small (5x1 m) field plots at the two sites on the Atherton Tablelands during February 2006. The target population was 30 plants per pot, but low seed viability meant that some plots contained fewer plants and were smaller. Once established all plots were managed using intensive seed production strategies including: strategic application of soluble nitrogen (80-100 kg/ha) following cleaning cuts (10 cm) undertaken when it was considered the previous cycle was completed; annual applications of fertiliser phosphorous (17 kg/ha), sulphur (22 kg/ha) and potassium (50 kg/ha); and irrigation to supplement rainfall and encourage vigorous growth. Weeds were controlled by hand-weeding or with selective herbicides (broad-leaved weeds). Management between the two sites was similar. Visual cues for

Table 1. **Reproductive and plant disease characteristics of ecotypes of *D. sericeum, H. contortus* and *T. triandra* assessed for seed production under intensive management in north Queensland. Means of two replicates at two sites (standard errors in brackets).**

Ecotype	**Collection site**		**Onset of flowering (Crop 1)**	**Seed harvesting period**		**Leaf rust rating[1]**			**Seed ergot rating[2]**		**Harvest rating[3]**	**Harvested seed yields[4]**	
	Lat. (º S)	**Long.** (º E)		**Summer/ autumn 2007 (Crop 2)**	**Winter/ spring 2007 (Crop 3)**	**Crop 1** Peak flower[1]	**Crop 2** 26 Feb. 2007	**Crop 3** 22 Aug. 2007	**Crop 1** Peak flower[1]	**Crop 3** 22 Aug. 2007		**Crop 2 (g/m^2)**	**Crop 3 (g/m^2)**
Dichanthium sericeum													
D19	19.51	144.26	Jun-Jul	24/1-28/3	23/10-20/12	0	0	0	4.3 (1.5)	8.8 (0.5)	H	7.29 (1.53)	3.38 (0.40)
D17	26.43	147.44	Jul-Aug	24/1-18/3	9/8-20/12	0	0.3 (0.3)	0	0.00	7.0 (1.0)	H	10.45 (1.17)	5.40 (0.65)
D18	26.43	147.44	Jun-Jul	28/1-24/3	23/10-20/12	0	0	0	0.00	1.5 (1.2)	H	12.09 (1.51)	4.78 (0.89)
D16	27.35	151.55	May-Jul	24/1-18/3	9/8-20/12	0	0	0	0.00	1.0 (0.0)	H	11.17 (1.48)	15.42 (3.19)
D01	29.66	149.30	May-Jun	24/1-18/3	23/10-20/12	0	0	0	0.5 (0.5)	1.3 (1.3)	H	10.39 (1.16)	12.79 (4.62)
D07	30.72	150.71	Jun	28/1-23/3	23/10-20/12	0	0	0	0.8 (0.5)	3.0 (1.9)	H	9.65 (2.27)	3.62 (0.09)
D11	30.77	147.80	Jun-Jul	24/1-21/3	9/8-20/12	0	0	0	0	0.5 (0.5)	H	10.21 (0.85)	8.05 (2.59)
Heteropogon contortus													
S12	16.42	145.21	May-Jun	1/3-21/3	9/8-20/12	5.8 (0.6)	5.3 (0.6)	4.0 (1.5)	7.5 (1.5)	5.8 (1.1)	H	2.65 (0.76)	2.68 (0.78)
S15	17.93	145.16	May-Jun	10/2-24/3	21/11-20/12	8.5 (0.3)	9.5 (0.3)	8.8 (0.8)	9.5 (0.3)	7.5 (0.7)	H	10.54 (1.30)	0.86 (0.18)
S13	18.14	144.81	Jun	2/2-24/3	23/8-20/12	1.3 (0.9)	1.5 (0.3)	3.3 (1.5)	4.5 (1.2)	2.3 (1.0)	H	5.45 (1.40)	21.37 (1.35)
S20	19.53	145.74	May-Jun	14/2-25/3	9/8-20/12	3.0 (1.1)	0.5 (0.3)	4.3 (0.9)	3.8 (0.5)	2.8 (1.4)	H	26.35 (3.77)	5.12 (2.79)
S23	20.41	144.44	Jun-Aug	14/2-24/3	13/11-20/12	3.3 (1.5)	5.0 (0.7)	4.7 (1.2)	5.3 (0.9)	3.7 (1.2)	H	8.07 (2.01)	3.42 (0.48)
S08	23.98	148.11	Jun	8/2-21/3	9/8-20/12	3.3 (0.9)	1.5 (0.3)	4.0 (1.5)	8.0 (0.6)	2.8 (1.2)	H	53.58 (9.53)	12.95 (0.20)
S06	25.00	150.04	Jun	8/2-24/3	9/8-20/12	2.0 (0.7)	0.8 (0.3)	2.5 (0.3)	6.0 (1.3)	2.8 (1.2)	H	81.13 (9.61)	11.40 (2.02)
S07	27.63	150.29	Jun	5/2-17/3	13/11-20/12	1.5 (0.7)	8.5 (0.5)	5.5 (2.6)	6.0 (1.7)	1.8 (0.5)	H	57.25 (7.84)	2.16 (0.04)
S01	27.98	148.03	Jun	5/2-21/3	13/11-20/12	5.0 (0.9)	9.0 (0.4)	5.5 (1.7)	7.8 (0.9)	3.3 (1.4)	H	14.77 (3.40)	1.63 (0.47)
Themeda triandra													
K30	16.71	145.64	No flowers	3/3-27/3	None	0	2.0 (0.0)	4.0 (0.0)	-	0	H	15.23 (6.80)	No flowers
K29	20.15	144.34	Oct-Nov	14/2-24/3	8/8-6/12	0	0	0	-	0	H (L)	109.10 (1.3)	12.02 (7.24)
K28	22.57	145.35	Nov	13/2-20/3	6/12-20/12	0	0.5 (0.3)	0	-	0	H	126.26 (10.9)	1.27 (1.27)
K24	26.55	148.19	May-Jun	13/2-17/3	13/11-20/12	0	0	0	0.0	0	H (L)	47.53 (11.79)	24.65 (2.81)
K20	27.97	149.54	May-Jun	13/2-17/3	13/11-20.12	0.3 (0.3)	0	0	1.0 (1.0)	0	H	34.14 (3.90)	27.16 (7.88)
K17	28.44	146.94	Sep	8/2-14/3	13/11-20/12	0	0	0	-	0	H (L)	109.42(*)	312.04 (*)
K14	29.78	145.99	Jun	14/2-14/3	21/11-20/12	0	0	0	0.0	0	H (L)	119.43(*)	44.82 (*)
K13	31.02	146.71	Jun	14/2-22/3	13/11-20/12	0	1.0 (*)	0	-	0	H	123.21(*)	97.34 (*)

[1] visual scored ratings of the proportion of leaves containing rust: 0 = no rust detected, 1 = rust detected on 10% of leaves, 10 = rust detected on all leaves

[2] visual scored ratings of the proportion of seed heads containing ergot during active flowering periods: 0 = no ergot detected, 1 = ergot detected on 10% of heads, 10 = ergot detected on all leaves. No ergot detected during Crop 2. * refers to the only plot

[3] based on minimum and maximum seed presentation heights measured 3-4 weeks after the onset of flowering in Crop 2 (in brackets refers to Crop 1 if different to crop 2): H = readily accessed by harvesting machinery; L = poor access due to lodging (decumbent culms); P = low culm population. * refers to the only plot.

[4] Hand-plucked progressively, usually weekly, and always targeting the recovery of mature seed. * refers to the only plot.

harvesting of mature seed were developed during the first seed production cycle and thereafter seed was sequentially harvested by hand, usually weekly.

All ecotypes were assessed for growth characteristics (not reported here) and reproductive development monitored weekly between February 2006 and December 2007 (Table 1). The prevalence of certain diseases detected in the first cropping cycle was measured during the reproductive phases of each cropping cycle. Harvested seed yields were expressed as unprocessed material per unit area of the plot at the time of harvest. The number of viable caryopses per unit weight of harvested material of selected ecotypes was measured to estimate the planting value of the three species. Disease and seed yield data were expressed as means across the four replicates and variation as standard errors. (Factorial) analysis of variance was not reported because measurement trends were similar across replicates and between sites.

RESULTS AND DISCUSSION

Ecotypes of all species grew well at both sites over the study period, indicating that the Atherton Tablelands production area is suitable for vegetative growth of these species. However, growth was checked by flooding associated with a March 2006 cyclone and extremely high rainfall during the 2007-08 wet season. Also, a cleaning cut during late March 2007 killed plants of some ecotypes (unpublished data).

Three production cycles were completed over 18 months: the first (Crop 1) following establishment and the other two (Crops 2 and 3) following cleaning cuts on 13-14 December 2006 and 30 March 2007 (Table 1). Flowering was first measured in some ecotypes of all species 3 months after transplanting into the field (when plants were five months old) and most seed production occurred between May and September. In the second production cycle mature seed was produced between January and March, 6 to 15 weeks after the cleaning cut. However, the presentation of mature seed was delayed in the cyclone-affected crop, with seed presented between August and December following the late March cleaning cut. Timing of flowering and seed presentation varied between, and within, the three species. In general, the *D. sericeum* ecotypes flowered earliest in summer and the *D. sericeum* and *H. contortus* in winter, whereas the *T. triandra* ecotypes tended to flower later than the other two species (Table 1). One *T. triandra* accession only flowered during summer.

Harvested seed yields were highly variable between species and ecotypes and appeared to be influenced strongly by leaf and seed-head diseases, particularly for ecotypes of *H. contortus* and *D. sericeum*. A leaf rust (*Puccinia* sp.) was detected on all ecotypes of *H. contortus* in both summer and winter crops and damage levels were consistent between ecotypes and sites (Table 1). Ecotypes with a high incidence of rust tended to have low seed yields. A seed-head ergot (*Claviceps pusilla*) was detected in all winter seed crops of *H. contortus* and most of *D. sericeum*, although often incidences were often low. Although visible ergot was not associated with depressed seed yields, seeds from heads affected by ergot were mostly non-viable.

Overall, the best yields of mature seed were collected from the summer grown crops, although some *D. sericeum* ecotypes produced high yields in both summer and winter grown crops. One *H. contortus* and one *T. triandra* ecotype produced highest yields during winter (Table 1). For *D. sericeum*, high-yielding ecotypes produced 10-15 g intact seed/m^2. Higher yields were achieved for the best-performing ecotypes of *H. contortus* (53-81 seeds/m^2) and *T. triandra* (109-126). The better yields of seed in spikelets were comparable to that of some exotic chaffy grasses produced commercially on the Atherton Tablelands (150-250 kg/ha or 15-25 g/m^2). Improved management of the three native grasses may have resulted in higher yields.

Caryopsis content of harvested material has a large effect on the commercial value of the three species. Physical examination of mature seed caryopses of selected high-producing ecotypes provided very different expectations of plant value amongst the species: *D. sericeum* (~ 650 caryopses/g unprocessed material), *H. contortus* (~ 60); T. *triandra* (~10). When this is taken into consideration, estimates of useful seed harvested per unit area were higher for some *D. sericeum* (6500-9750 seeds/m^2) ecotypes than *H. contortus* (3180-4860) and were much lower in *T. triandra* (1090-1260). This compares to approximately 15,000 viable seeds/m^2 for *Bothriochloa insculpta* produced commercially on the Atherton Tablelands and 6,000/m^2 for the native annual grass *Setaria surgens* grown recently in small crops by the research team (both as a single harvests) (Cox *et al*., 2007).

Presentation for harvest varied significantly between the three species (Table 1), with implications for commercial adoption. The *D. sericeum* ecotypes tended to present seed above the leaf canopy, but readily shed seed once mature. We have found, in separate work, repeated brush harvesting of this species results in the collection of a large proportion of the mature seed presented over the crop, and we would expect to recoup similar yields to those hand-harvested weekly during this study. The *H. contortus* ecotypes presented seed at a harvestable height and the seed was retained in the crop as round, tangled masses of mature seed. Seed accumulated in the leaf canopy at a harvestable height, so that a large proportion of seed could be harvested at one time. In *T. triandra* there considerably less opportunity to harvest a large proportion of the mature seed produced over the crop cycle, a result of ecotype variability in seed presentation height and failure to accumulate shed seed in the leaf canopy.

Overall, these small scale trials indicate potential to grow seed crops of carefully selected ecotypes of *D. sericeum* and *H. contortus* under intensive management on the Atherton Tablelands, but considerably lower levels of viable seed production are likely for *T. triandra*. Crop agronomy and harvesting techniques need to be further developed under larger-scale production, particularly for *H. contortus* and *T. triandra,* before commercial adoption can be expected.

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