Seed production potential in bred populations and cultivars of *Setaria sphacelata*

J.B. HACKER
Division of Tropical Crops and Pastures, CSIRO, Brisbane, Australia

Abstract

Poor seed production is a major limitation to use of the winter-green cultivar *Setaria sphacelata* cv. Narok and the botanical variety *splendida*. Six experimental varieties with yields and winter-greenness comparable to Narok, but which had shown evidence of higher tiller fertility and three experimental varieties bred to incorporate botanical fertility into var. *splendida*, were compared with cvv. Nandi, Narok and Kazungula and another winter-green accession, for seed production.

The study was conducted over a two-year period, when swards were 4-6 years old. Seed production was assessed on a continuous basis and comparisons made at peak seed production.

Mean cleaned-seed yields of Nandi, Narok and Kazungula were 89, 57 and 293 kg/ha/annum, respectively. Five of the six winter-green experimental varieties yielded 100-260 kg/ha/annum, 2-4 times as much cleaned seed as did Narok. The three experimental varieties derived from var. *splendida* averaged 118-156 kg/ha/annum. For most varieties, germination 6 months after harvest exceeded 50%.

Seed yield was strongly correlated with seed weight per unit length of ripe inflorescence but, unexpectedly, only weakly correlated with inflorescence number. This was associated with a strong negative correlation between inflorescence length and number, which is considered to be an attribute of the sample of populations studied rather than a general phenomenon. At peak seed yield, 25-72% of inflorecences were at a pre-ripeness stage and would not have contributed to seed yield.

The data on seed yield of old stands of these experimental setaria varieties contributed to the decision to release for commercial use the cultivars Splenda and Solander.

Correspondence: Dr J.B. Hacker, Division of Tropical Crops and Pastures, CSIRO, 306 Carmody Rd, St Lucia, Qld 4067, Australia.

Resumen

La pobre producción de semilla del cultivar verde de invierno Setaria sphacelata *cv. Narok y la variedad botánica* splendida *es la mayor limitante para su uso. Seis variedades experimentales con rendimiento y verdor en invierno comparables a los de Narok, pero que han mostrado evidencias de una mayor fertilidad de los rebrotes, y tres de las variedades experimentales cruzadas para incorporar fertilidad botánica en la var.* splendida *fueron comparadas, en términos de producción de semilla, con los cvv. Nandi, Narok y Kazungula y otra accesión con verdor en invierno.*

El presente estudio fue conducido durante dos años, cuando la pastura tenia 4-6 años de edad. La producción de semilla fue registrada continuamente y las comparaciones se hicieron en el pico de producción.

El promedio de rendimiento de semilla limpia fue de 89, 57 y 293 kg/ha/año para Nandi, Narok y Kazungula respectivamente. Cinco de las seis variedades experimentales con verdor en invierno rindieron 100-260 kg/ha/año, 2-4 veces más que Narok. Las tres variedades experimentales derivadas de la var. splendida *promediaron 118-156 kg/ha/año. La germinación 6 meses después de la cosecha fue superior al 50% para la mayoría de las variedades.*

El rendimiento de semilla estuvo altamente correlacionado con el peso de semilla por unidad de longitud de las inflorescencias maduras pero, inesperadamente, tuvo solamente una correlación débil con el número de inflorescencias. Esto fue asociado con una fuerte correlación negativa entre el largo y el número de inflorescencias, lo cual fue considerado como un atributo de la muestra de la población estudiada y no como fenómeno general. En el pico de producción de semilla,

25-75% de las inflorescencias estaban en la etapa de pre-maduración y podrían no haber contribuido a la producción de semilla.

La información sobre la producción de semilla de pasturas viejas de estas variedades experimentales de setaria contribuyeron a la decisión para la liberación comercial de los cultivares Splenda y Solander.

Introduction

Commercial use of tropical pasture grasses is frequently restricted by low yields of seed and consequent high seed prices. Although many tropical pasture species produce high yields of seed, in many cases only a small percentage is retrievable by normal harvesting procedures (Humphreys and Riveros 1986). This is due to a number of factors including a protracted flowering season, uneven flowering within and between plants, non-synchronized flowering within the inflorescence and early abscission of spikelets. In setaria (*Setaria sphacelata*) it has been calculated that only 5-7% of the potential seed yield is recovered (Hacker and Jones 1971). In some species seed yields may be further reduced by low biological fertility and/or low tiller fertility.

At the time the trials reported in this paper were initiated, there were three setaria cultivars available in Australia, Nandi, Kazungula and Narok. The last cultivar, favoured for its winter-greenness and winter productivity in the subtropics and montane tropics (Hacker 1991), had a reputation for particularly low seed yields in comparison with other cultivars, especially Kazungula. The poor seed production resulting from the low tiller fertility of post-establishment year crops resulted in high seed prices for the cultivar.

Clearly, there was a need for a cultivar with the good agronomic characteristics of winter-greenness and winter yield of Narok and higher seed yields. In a previous paper (Hacker 1991), yield and winter-greenness of a range of experimental varieties were discussed. Although the regular 6-weekly cutting regime of the experiment was designed to provide data more relevant to a grazing situation than to seed production, counts of inflorescence density suggested that some of the experimental varieties could have superior seed-production attributes to Narok.

In this paper, the seed production of nine experimental setaria varieties is compared with that of cvv. Nandi, Narok, Kazungula and one winter-green accession. Six of the experimental varieties were based on winter-green x lowland parents and had been selected for winter-greenness and winter productivity; all six were comparable in terms of winter-greenness to Narok and thus, if markedly superior in terms of seed production, would be considered for release to replace Narok. The other three were based on hybrids between the late flowering and botanically very infertile var. *splendida* and fertile accessions of the Kazungula type; these populations had been selected for botanical fertility and conformity to the *splendida* morphotype. These were included because of the good production characteristics of the botanical variety *splendida* (T.R. Evans and J.B. Hacker, unpublished data) and the perceived need in wet tropical areas of Australia and overseas for a seed-producing cultivar of this type.

Materials and methods

The experimental area was located at Lawes, south-east Queensland, and comprised two contiguous trials described in a previous paper (Hacker 1991). These two trials had been sown in October 1974; each consisted of a randomized block with three replicates and thirteen populations of *Setaria sphacelata*. One of the trials had been nitrogen-fertilized since 1974, the other had been sown to *Neonotonia wightii*. Plot size was 8 m x 2 m, with intervening 1 m alleyways.

The 13 setarias are listed in Table 1. The prefixes LH and EH are abbreviations of Late Hybrid and Early Hybrid respectively. D is an abbreviation of Drought, as one of the parental accessions, CPI 32714, originated from a comparatively low rainfall area (Hacker 1991) and had the gross morphology of a drought-tolerant ecotype. A, B and C refer to three populations derived from each original set of parental crosses.

Legume was eliminated from the *N. wightii* plots in September 1978 by spraying with 2,4-D and 2,4,5-T. This resulted in six replicates, four of which were used directly in the experiment; the fifth and sixth were used for calibration. The whole experiment was cut to a height of 10 cm on October 23 1978, and on October 25, 300 kg/ha superphosphate, 150 kg/ha KCl and 50 kg/ha N as urea was applied and the trial irrigated. Thereafter, 50 kg/ha N was applied at monthly intervals, excluding May, June and July 1979. On January 25 and November 3, 1979 superphosphate and KCl were applied at the same rate as previously. The experiment was irrigated at the start of each month to make up to the mean rainfall for the previous month for the site, which ranged from 40 mm in May to 127 mm in January.

Two permanent 2 m x 0.5 m quadrats were located within each of the four replicates of the 13 setarias. Initially, all inflorescences were counted and classified within these quadrats, but numbers became too large to count in the time available and for those populations with very high numbers, the study area was reduced to 1 m x 0.5 m. In the second harvest year, the reduced size was used throughout. Inflorescences were counted and classified into pre-anthesis, anthesis, ripe (Nr), and shedding (Ns). The ripe category was defined as 0-50% shed, the shedding as >50% shed.

Each week, ten ripe and ten shedding inflorescences were harvested from all 13 varieties from the fifth and sixth replicates. Lengths of these were measured (Lr, Ls); the inflorescence of *Setaria sphacelata* is a cylindrical spike-like panicle which, although very variable in length, is relatively constant in diameter. They were then threshed by hand, aspirated and the clean seed weighed (Wr, Ws). For each population, weight of seed per centimeter length of inflorescence was calculated separately for ripe and shedding heads (Wr/Lr, Ws/Ls). From these values, total clean seed production per square meter from the experimental plots was calculated as Nr(Wr/Lr) + Ns(Ws/Ls).

Harvested cleaned seed was stored at 25 °C for 16 weeks and then samples of 100 seeds were germinated (30 °C-20 °C day-night, 12 hour day). For harvests of November 29, 1978 to February 7, 1979, germination was on pads moistened with water; thereafter, a 0.2% solution of KNO_3 was used. Germinated seeds were counted at weekly intervals for three weeks.

For each population, after peak flowering all six plots (four experimental + two calibration) were cut back to a height of 10 cm to initiate another flowering cycle. The plots were cut back when ripe and shedding heads exceeded 50% of the total head number for three successive weeks. The entire experiment was cut back on September 10, 1979 to initiate a new flowering cycle.

For comparison of estimated total seed production of populations, which differed markedly in flowering behaviour, analysis of variance was carried out on mean data from peak harvest periods of two weeks. Analyses of variance for inflorescence length assumed successive weeks and ripe and shedding inflorescences as independent replicates, and for seed weight per unit length of inflorescence, successive weeks were assumed to be independent. For graphical presentation of results, data were smoothed by averaging over each pair of succeeding weeks.

Results

Averaged over the two years, cleaned seed yield ranged from 51 kg/ha to 293 kg/ha (Table 2).

Table 1. Peak yields[1] of cleaned seed of cultivars and populations of *Setaria sphacelata* and germination 16 weeks after harvest. **(1978-79)**

	Jan harvests, 1979			Feb-May harvests, 1979			
	Dates	Seed yield	Germination	Dates	Seed yield	Germination	Total seed yield
		(kg/ha)	(%)		(kg/ha)	(%)	(kg/ha)
Nandi	9,16/1	60	49	15,22/5	32	23	92
Narok				27/2,6/3	95	81	95
Kazungula				27/2,6/3	485	62	485
LHA				13,20/3	237	57	237
LHB				6,13/3	211	48	211
LHC				13,20/3	206	64	206
EHA				6,13/3	80	70	80
EHB				27/2,6/3	168	51	168
EHC				27/2,6/3	187	54	187
DA	16,23/1	77	40	17,23/4	92	66	170
DB	16,23/1	158	41	17,23/4	90	58	247
DC	9,16/1	86	53	17,23/4	62	66	148
33453	23,30/1	78	43	1,8/5	95	53	173
LSD 5%		46	NS		60	20	68

[1] Peak yield is based on the mean yield from two consecutive weeks

Table 2. Peak yields[1] of cleaned seed of cultivars and populations of *Setaria sphacelata* and germination 16 weeks after harvest. **(1979-80)**

	Nov-Dec harvests, 1979			Apr-May harvests, 1980				
	Dates	Seed yield	Germination	Dates	Seed yield	Germination	Total seed yield	Mean yield 1978-79 and 1979-80
		(kg/ha)	(%)		(kg/ha)	(%)	(kg/ha)	(kg/ha)
Nandi	28/11,5/12	53	29	14,21/5	32	36	85	89
Narok				14,21/5	18	66	18	57
Kazungula				2,10/4	101	76	101	293
LHA				14,21/5	74	44	74	156
LHB				21,28/5	40	22	40	126
LHC				7,14/5	30	47	30	118
EHA				2,10/4	22	69	22	51
EHB				26/3,2/4	31	61	31	100
EHC				2,10/4	50	51	50	119
DA	5,12/12	150	34	2,10/4	104	56	254	212
DB	5,12/12	145	47	2,10/4	127	63	272	260
DC	5,12/12	179	55	2,10/4	77	68	256	202
33453	12,18/12	91	61	2,10/4	54	86	145	159
LSD 5%		83	NS		38	22	75	59

[1] Peak yield is based on the mean yield from two consecutive weeks

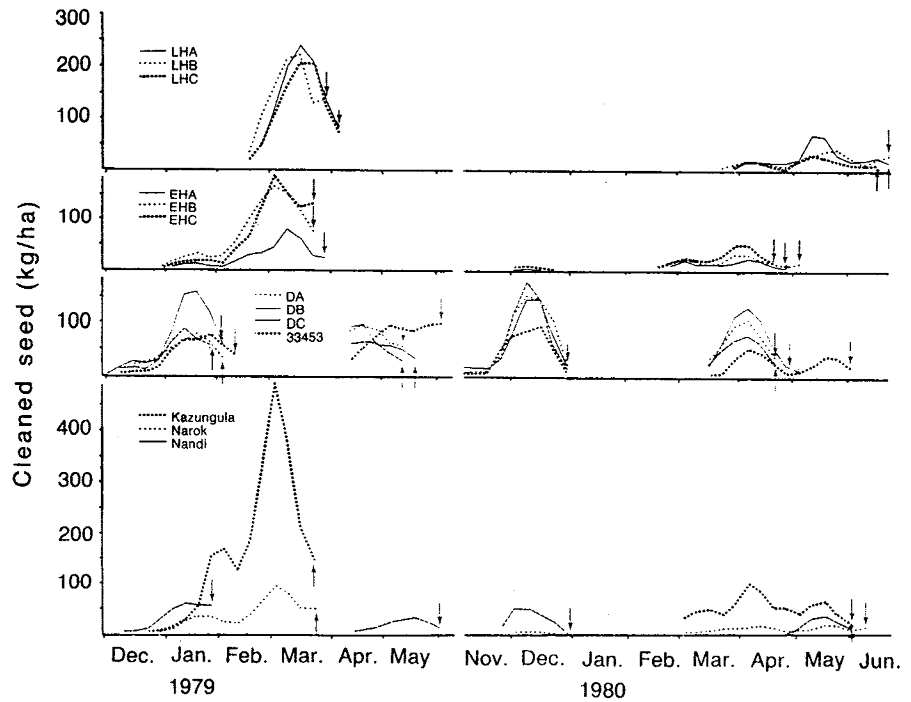

Figure 1. Production of cleaned seed of Nandi, Narok and Kazungula setaria, CPI 33453 and nine experimental populations (arrows indicate when each population was cut back).

Yields of cleaned seed varied widely between years, seasons and varieties (Tables 1 and 2, Figure 1). Yields in 1978-79 were generally above those of 1979-80. Five varieties produced two seed crops per season — Nandi, CPI 33453, DA, DB, DC, and, as a generalization, the first crop was the heavier. There was also a minor flowering of EHA, EHB, EHC and Narok in December 1979 which yielded negligible quantities of seed and these varieties were therefore not cut back at this stage. All varieties exhibited a relatively protracted seeding period, lasting from six to eight weeks.

Of the commercial cultivars, the highest yielding was Kazungula, with about five times the seed yield of Nandi and Narok in 1978-79 (Table 1). However, in 1979-80 seed yield from the single Kazungula flowering was only marginally higher than that of the combined flowerings of Nandi, albeit with a much higher germination percentage (Table 2). Substantially higher seed yields were obtained in both years from the winter-green hexaploids (DA, DB, DC and CPI 33453) than from Narok. The tetraploid winter-green populations (EHA, EHB, EHC), though, were inconsistent, with high yields in the first year but low in the second. Overall, germination percentages were high, mostly ranging from 40-80%, indicating a relatively high full-seed content of the harvested seed.

In both years, populations exhibited a 3-fold difference in inflorescence length and a 6-fold difference in total inflorescence number at peak seed yield (Tables 3 and 4). For all varieties, a high percentage of inflorescences, ranging from 25% to 72%, were classed as pre-anthesis or anthesis and would not have contributed to harvested seed yield. Varieties showed little consistency with regard to the proportion of inflorecences contributing to harvested seed yield, although Nandi had exceptionally low values for the first harvest in both seasons (Tables 3 and 4).

The large numbers of inflorescences of the hexaploids were associated with a much shorter length than occurred in other populations. Kazungula was unusual in combining long inflorescences with a high inflorescence number in 1978-79, although in 1979-80 the total number of inflorescences at peak flowering was halved. This reduction in inflorescence number was not associated with a marked change in inflorescence length.

Development of inflorescence numbers is shown for Nandi, Narok and Kazungula for the 1979-80 harvest year (Figure 2). Nandi, which produced two seed crops, showed a rapid increase

Table 3. Mean inflorescence length, cleaned seed weight per unit length of ripe inflorescence, numbers of inflorescences at different stages of development and percentage of inflorescences at anthesis and pre-anthesis at peak seed yield. **1978-79**

	Inflorescence length	Seed weight	Inflorescences per m²					A+PA
			PA[1]	A	R	S	Total	
	(cm)	(mg/cm)			(number)			(%)
January harvests, 1979								
Nandi	28.0	6.2	12	138	52	25	226	66
DA	14.7	10.3	17	121	79	163	380	37
DB	19.3	10.6	17	102	108	127	353	35
DC	14.6	12.1	17	175	92	50	334	58
33453	16.5	6.7	26	71	101	153	351	28
February-May harvests, 1979								
Nandi	38.2	8.2	12	24	19	7	62	60
Narok	38.0	9.8	8	45	42	33	128	42
Kazungula	37.3	15.5	21	120	131	115	387	36
LHA	35.7	14.7	25	81	76	13	195	56
LHB	43.1	11.9	24	65	83	16	188	47
LHC	46.3	11.1	23	49	73	12	156	46
EHA	37.9	5.0	16	72	70	77	234	38
EHB	43.0	8.6	10	66	90	41	207	38
EHC	38.5	9.4	16	77	99	76	268	36
DA	21.0	11.0	20	40	79	17	156	39
DB	16.7	9.7	18	44	94	17	173	35
DC	13.8	8.0	18	37	88	18	162	35
33453	15.6	11.0	17	71	109	12	208	42
LSD 5%	6.3	NS	NS	28	37	38	57	16

[1] PA, pre-anthesis; A, anthesis; R, ripe; S, shed

Table 4. Mean inflorescence length, cleaned seed weight per unit length of ripe inflorescence, numbers of inflorescences at different stages of development and percentage of inflorescences at anthesis or pre-anthesis at peak seed yield. **(1979-80)**

	Inflorescence length	Seed weight	Inflorescences per m²					PA+A
			PA[1]	A	R	S	Total	
	(cm)	(mg/cm)			(number)			(%)
November-December harvests, 1979								
Nandi	25.2	6.0	16	157	66	3	242	76
DA	13.1	8.9	24	98	217	159	498	29
DB	12.5	10.5	23	97	184	145	449	26
DC	12.9	10.6	27	122	223	174	546	33
33453	14.4	6.3	18	91	181	125	415	29
April-May harvests, 1980								
Nandi	31.3	2.2	17	106	90	15	228	56
Narok	30.4	5.9	9	35	21	15	81	55
Kazungula	34.0	10.1	15	99	60	22	196	58
LHA	33.6	6.8	12	51	58	19	140	44
LHB	34.0	6.7	13	38	37	21	110	47
LHC	36.0	6.0	8	42	36	10	96	54
EHA	36.3	2.3	8	67	49	50	174	41
EHB	41.4	4.2	2	88	37	17	143	62
EHC	35.1	4.3	6	76	66	26	175	47
DA	16.6	7.7	8	117	179	24	328	39
DB	17.2	12.0	9	80	144	9	241	36
DC	15.3	6.3	10	105	166	16	297	38
33453	17.2	7.8	17	113	77	1	209	67
LSD 5%	3.5	4.5	7	58	74	63	126	15

[1] PA, pre-anthesis; A, anthesis; R, ripe; S, shed

in inflorescence numbers during November and again in March; Kazungula inflorescence numbers increased rapidly in February. Both these cultivars had a period of several weeks of relatively constant numbers of ripe inflorescences. In contrast, numbers in Narok increased steadily from February to late May. What is not shown in Figure 2, though, is the component of inflorescences which aborted before emergence and hence were not amenable to classification and did not contribute to seed yield. These inflorescences emerged but lacked properly developed spikelets. Numbers of aborted inflorescences were not significant during the first harvest year but were more evident in the second year. On the January 23 assessment, 39% of inflorescences (averaged over populations) were classed as aborted. This could have been associated with hot winds earlier in the month.

There was a 3- to 5-fold range in seed weight per unit inflorescence length which only achieved statistical significance in 1978-79 (Tables 3 and 4). In both seasons, Kazungula had the highest value of the three cultivars, with Narok second and Nandi poorest. Seed weight per unit inflorescence length for the two seasons was correlated ($r = 0.55$; $P < 0.02$, $n = 18$).

Simple correlations between peak seed production and attributes which contributed to seed yield were calculated for the 36 peak harvests indicated in Tables 1 and 2:

	r
Inflorescence length	0.154 NS
Seed weight per unit length of ripe inflorescence	0.748 $P<0.001$
Number of ripe inflorescences	0.389 $P<0.05$
Number of ripe and shedding inflorescences	0.407 $P<0.05$
Total number of inflorescences	0.409 $P<0.05$

Discussion

The peak seed yields of the commercial cultivars in this investigation are in line with commercial and research experience in Australia and elsewhere. Averaged over 1978-79 and 1979-80, cleaned seed yields of Narok, Nandi and Kazungula were 57, 89 and 293 kg/ha respectively (Table 2). Kazungula is known to be a reliable seed producer, with markedly higher seed yields than Narok and Nandi. In the study of Bahnisch and Humphreys (1977) yield of pure seed of Narok rarely exceded 40 kg/ha. A more recent study by Li Shuan and Zhao Jun-Quan (1989)

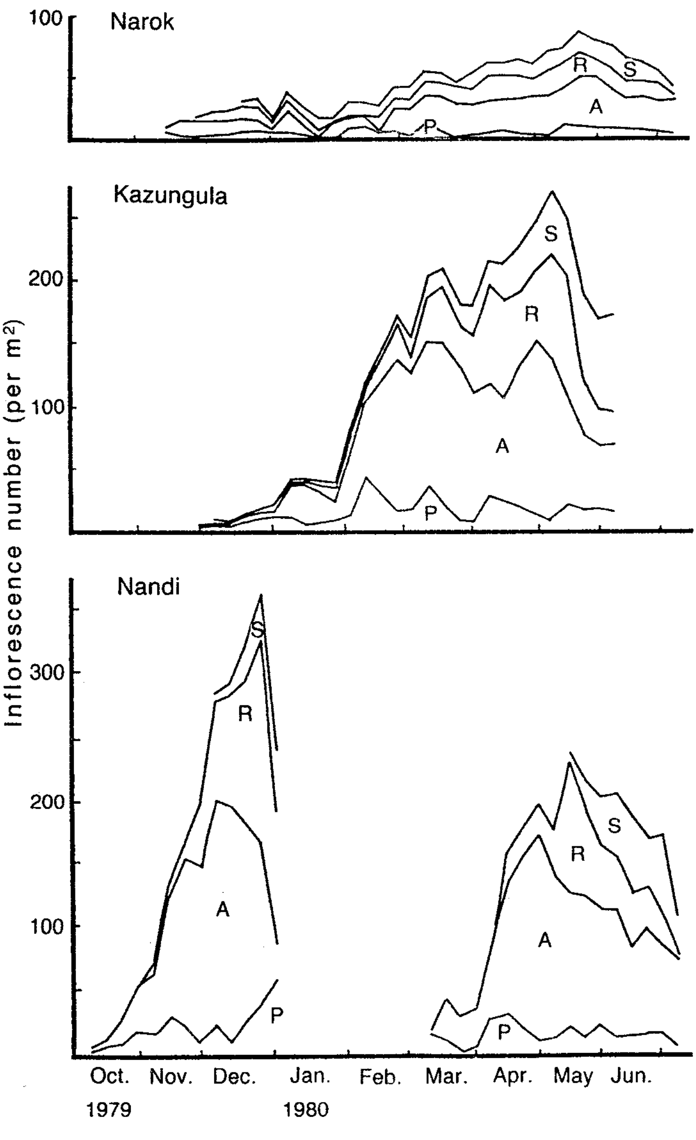

Figure 2. Floristic development in swards of *Setaria sphacelata* cvv. Narok, Kazungula and Nandi, 1979-80 season. (P - pre-anthesis; A - anthesis; R - ripe and up to 50% shed; S - more than 50% shed).

quotes figures for Narok seed production, averaged across a range of levels of N fertilizer, of 449 kg/ha. In the same region, seed yields of 680 kg/ha, of 70-80% purity and 25-35% germination have been obtained (Li Shuan, personal communication October 1990). These yields are exceptionally high and comparable yields have not been obtained elsewhere. In Kenya, the highest yields of pure germinating seed of Nandi II from a range of treatments was 48 kg/ha (Boonman 1972). Nandi II is considered to be the source material for the cultivar known as Nandi in Australia (R.J. Williams, personal communication).

The prime objective of this investigation was to determine whether any of the winter-green experimental varieties had superior seed-production potential to that of Narok. With the exception of EHA, all six of these experimental varieties and CPI 33453 had c. 2-4 times the seed production of Narok (Table 2). This was associated with a somewhat lower germination percentage in the first year but not in the second (Tables 1 and 2). However, germination percentages for all varieties were comparatively high by commercial standards. Following further, but as yet unpublished trials, in which response to N fertilizer in terms of seed production and tiller fertility of EHB and EHC was evaluated, EHB was released under the cultivar name Solander (Oram 1990).

The second objective was to investigate the seed-production potential of LHA, LHB, LHC, in which the breeding program was designed to introduce seed production into the var. *splendida* morphotype. The high average values of 118-156 kg/ha, with a germination percentage of 22-64%, confirm the botanical fertility of these experimental varieties. The cultivar Splenda was subsequently released as a combination of LHA and LHB (Anon 1988, Oram 1990).

Despite the attempt to identify peak seeding dates for the different populations in this study, there were pronounced differences in peak seed yield between years. For most populations, yields were much higher in the first year than in the second. The only populations for which this was not so were the early flowering group (DA, DB, DC, 33453, Nandi), all of which cropped twice each year.

Published data for Narok (Bahnisch and Humphreys 1977) and for CPI 33452, the accession from which it was selected (Hacker and Jones 1971), indicate that it normally produces two seed crops in a season in southern Queensland, one in December-January and the other around May. Unpublished data also indicate a similar phenology for EHA, EHB and EHC (J.B. Hacker, unpublished data). In the present experiment, failure to flower twice in 1978-79 could be attributable to the late defoliation on October 23. Peak flowering for Narok was at the end of February, about two months later than would be expected.

In contrast, over 1979-80 growth proceeded from early spring and flowering tillers were evident on the earliest populations from October 3. It would have been expected that strong flowering peaks would have been evident, at least for Narok and EHA, EHB and EHC, in December, but flowering was not pronounced until much later. A substantial proportion of inflorescences which emerged in January were aborted and did not contribute to the data presented; it is probable that this was associated with a period of hot, dry winds. This could have further contributed to the low seed yields in the second season. Setaria is a species of relatively humid adaptation and the experimental site would not be considered optimal for commercial seed production. Although irrigation was provided, low humidity associated with hot winds is believed to have had an adverse effect.

The inflorescence densities for Narok in this experiment, 128 and 81 per square metre, are below the values cited by Bahnisch and Humphreys (1977) for first and second year crops and by Li Shuan and Zhao Jun-Quan (1989) for one and two year old crops. In Bahnisch and Humphrey's study, numbers dropped to less than 40 inflorescences/m^2 in the second year. The crop in the current study was 5-6 years old, so the comparatively low inflorescence density for Narok was anticipated. The inflorescence density values for the experimental winter-green varieties DA, DB, DC, EHA, EHB and EHC and the accession CPI 33453 were 22-197% and 77-574% higher than those for Narok in 1978-79 and 1979-80 respectively. The relative advantage of the D series was counterbalanced by their short inflorescences, only half the length of the E series varieties. A further attribute of the D series varieties was their rapid and early flowering. This attribute was considered to be to their potential disadvantage as grazing plants, and for this reason none of them was selected for release to industry as a new cultivar.

No data were assembled in this study on botanical fertility of the populations studied. The 3-fold to 5-fold variation in seed wt/cm of inflorescence could be associated with differences in botanical fertility or in spikelet density along the culm rhachis. Although inflorescences with up to 50% shed were included in the 'ripe' class, there was a statistically significant correlation of seed wt/cm between years, suggesting real biological differences. At either end of the spectrum were Kazungula, with 13 and Nandi, with 5 mg/cm.

The relatively poor correlations between (a) inflorescence length and seed production and (b) inflorescence number and seed production are associated with a negative correlation between inflorescence length and number ($r = -0.61$, $P < 0.001$). In consequence, it was seed weight per unit inflorescence length in this experiment which most influenced seed yield. The negative relationship between inflorescence length and number is likely to be a function of the particular genotypes included in this study, and there is no reason to suppose that, within a population, selecting for greater inflorescence number will necessarily result in a reduction in inflorescence length.

It was concluded from this study that the experimental varieties, including the winter-green varieties, were sufficiently promising in terms of seed production in old stands to warrant consideration for release as commercial cultivars. Solander, derived from EHB, was registered and released in 1985 and is becoming increasingly recommended and widely sown, especially in north-eastern New South Wales (T. Launders, personal communication November 1990). Splenda, derived from a combination of LHA and LHB, was registered in 1982. Since then it has shown particular promise in trials in wet tropical areas of South-East Asia and Oceania (T.R. Evans, personal communication). It was accepted under the Australian Plant Variety Rights scheme in 1989 (Anon 1988) and accepted for release in Australia the same year.

Acknowledgments

I am grateful to Messrs P. Cavu and P. Gibbons for competent technical assistance.

References

Anon (1988) Application No:88/009. *Plant Varieties Journal,* **1**, 10-12.

Bahnisch, L.M. and Humphreys, L.R. (1977) Urea application and time of harvest effects on seed production of *Setaria anceps* cv. Narok. *Australian Journal of Experimental Agriculture and Animal Husbandry,* **17**, 621-628.

Boonman, J.G. (1972) Experimental studies on seed production of tropical grasses in Kenya. 3. The effect of nitrogen and row width on seed crops of *Setaria sphacelata* cv. Nandi II. *Netherlands Journal of Agricultural Science,* **20**, 22-34.

Hacker, J.B. (1991) Evaluation of bred populations and cultivars of *Setaria sphacelata. Tropical Grasslands,* **25**, 245-252.

Hacker, J.B. and Jones, R.J. (1971) The effect of nitrogen fertilizer and row spacing on seed production in *Setaria sphacelata. Tropical Grasslands,* **5**, 61-73.

Humphreys, L.R. and Riveros, F. (1986) *Tropical Pasture Seed Production.* FAO Plant Production and Protection Paper 8. (FAO: Rome.)

Li Shuan and Zhao Jun-Quan (1989) Effect of level and source of nitrogen fertilizer on the pure seed yield of *Setaria sphacelata* cv. Narok in Yunnan Province, southern China. *Proceedings of the 16th International Grassland Congress,* Nice, pp. 679-680.

Oram, R.N. (1990) *Register of Australian Herbage Plant Cultivars.* (CSIRO: Canberra).

(Received for publication December 12, 1990; accepted May 31, 1991)