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SESAME RESEARCH REPORT 1995-96 WET SEASON KATHERINE

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1995-96 WET SEASON

KATHERINE

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SUSTAINABLE AGRICULTURE

THE DEPARTMENT OF PRIMARY INDUSTRY AND FISHERIES IS COMMITTED TO THE PRINCIPLES AND PRACTICES OF SUSTAINABLE AGRICULTURE

Definition:

Sustainable agriculture is the use of practices and systems which maintain or enhance:

- the economic viability of agricultural production:
- the natural resource base: and
- other ecosystems which are influenced by agricultural activities.

Principles:

1. Agricultural productivity is sustained or enhanced over the long term.
2. Adverse impacts on the natural resource base of agricultural and associated ecosystems are ameliorated, minimised or avoided.
3. Harmful residues resulting from the use of chemicals for agriculture are minimised.
4. The nett social benefit (in both dollar and non-dollar terms) derived from agriculture is maximised.
5. Agricultural systems are sufficiently flexible to manage risks associated with the vagaries of climate and markets.

SUSTAINABLE AGRICULTURE IN THE NORTHERN TERRITORY

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1. Introduction

History of sesame research and development in the Northern Territory

There has been substantial research in identifying crops which are possible alternatives to maize, soybean, mungbeans and sorghum for the Northern Territory.

One crop that has shown potential for the Katherine region is sesame. Intensive research with sesame was initiated in the 1987-88 wet season. Research since then has included cultivar, sowing date, population, crop establishment, nutrition, weed control, disease monitoring, harvesting and seed maintenance experiments. Development of pure cv. Yori 77 seed and an improved cultivar for northern Australia has been given the highest priority. This research was jointly funded by Grains Research and Development Corporation and Rural Industries Research and Development Corporation.

A superior sesame genotype (Y1:44) was selected in 1992-93. Seed multiplication and demonstration areas of the new genotype were sown in January 1995. Significant differences in plant morphology and farmer adoption of zero tillage technology has highlighted the need to re-assess some agronomic practices, eg. row spacing by population interactions for sesame.

In March 1995, the First Australian Sesame Workshop was convened in Darwin and Katherine. Twenty five papers were presented during formal sessions and have been reproduced in the 'Proceedings of the First Australian Sesame Workshop'. During group discussions, strategies for a coordinated approach to the expansion of the Australian sesame industry were developed. Critical issues identified were:

1. Improving sesame cultivars under a national breeding program.
2. Establishing an Australian Sesame Association which would liaise with the Australian Oilseeds Federation.
3. Defining standards for unhulled seed for both confectionery and industrial use.
4. Assembling a national data base to be used to develop a 'Growers Manual' and a sesame crop growth model.
5. Establishing a nationally coordinated research program.

These issues have been extensively covered in a strategic plan document for the Australian Sesame Industry.

This year, two experiments were successfully completed, the first was the completion of the Plant Breeders Rights documentation for 'Edith' (Y1:44) and the second a time of sowing evaluation.

2. General Methods

2.1 *Sites and Soils*

This year's experiments were undertaken at Katherine Research Station (14^0 28'S, 132^0 18'E The soil type used was a Fenton clay loam, (Lucas *et al.* 1985). Soil fertility analysis is presented in Table 2.1.

2.2 *Seasonal Conditions*

The 1995-96 wet season was characterised by poor land preparation rains in November and December. The first sowing rains occurred after the 16 January with minimal follow-up rains in February. Rainfall during March was below average while there were one substantial 'knock-me-down' rainfall event in April.

Total rainfall for November '95 to May '96 at Katherine was 669.8 mm (Table 2.2).

2.3 *Land Preparation and Weed Control*

Land preparation for the time of sowing and genotype evaluation experiments was by zero-tillage techniques. Generally the experimental site was mulched 14 days before applying Round-up CT® @ 3.0 L/ha. Killing the mulch occurred 4 days before sowing. Metoalchlor (Dual®) @ 1.5 L/ha was sprayed post sowing to control potential grass weeds. Further manual weed control occurred as required.

2.4 *Fertiliser Application*

Basal fertiliser applications are detailed in Table 2.3.

2.5 *Insect Control*

Both experiments were sprayed as required with either endosulphan @ 1.0 L/ha or Ambush® @ 100 ml/ha

2.6 *Irrigation*

Supplementary irrigation (between 12 and 23 mm per application) was applied to both experiments every 4 days depending on the previous rainfall event.

Table 2.1 Soil nutrient status

Soil analysis[1]	Paddock H6
Cond (ms/cm)	0.14
pH	6.7
Avail. P (ppm)	9
Avail. K (ppm)	417
Avail Ca (ppm)	960
Avail. S (ppm)	11
Avail Mg (ppm)	220
Avail. Cu (ppm)	3.2
Avail. Zn (ppm)	1.4
Avail. B (ppm)	0.3

[1] Soil depth, 0 - 15cm

Table 2.2 Rainfall, pan evaporation, radiation and mean temperatures at Katherine

	Nov	Dec	Jan	Feb	Mar	Apr	May	
Monthly rainfall (mm)								**Total**
Katherine	54.8	146.9	198.5	57.4	91.5	120.5	0.2	669.8
Mean	83.3	191.6	228.6	210.2	162.7	32.8	5.1	914.3
Mean maximum daily temperature (^{0}C)								
Katherine	39.0	35.6	36.9	35.6	33.8	34.5	32.3	
Mean	37.8	36.2	34.6	34.1	34.3	33.9	32.0	
Mean minimum daily temperature (^{0}C)								
Katherine	24.2	24.2	24.2	24.1	22.5	18.7	17.0	
Mean	24.3	23.9	23.7	23.4	22.3	19.5	16.2	
Mean daily radiation (MJ/m^2)								
Katherine	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	
Mean	24.6	24.2	21.9	22.5	21.7	21.7	22.0	
Mean monthly evaporation (mm)								
Katherine	255	217	183	197	183	162	170	
Mean	275	242	194	156	173	186	180	

N.A. Not available

Table 2.3 Basal fertiliser applications

Experiment	Fertiliser	Rate	Application date
Time of sowing	19:13	96 kg/ha (18kg N/ha, 12 kg P/ha)	day before sowing
	Urea	96 kg/ha (44 kg N/ha)	day before sowing
	Sulphate of Ammonia	100 kg/ha (20 kg N/ha)	approx 27 days after sowing
Genotype	19:13	96 kg/ha (18kg N/ha, 12 kg P/ha)	27 December
	Urea	96 kg/ha (44 kg N/ha)	27 December
	Sulphate of Ammonia	100 kg/ha (20 kg N/ha)	30 January

3. Evaluation of sesame genotypes in the 1995-96 wet season

Introduction

A range of sesame genotypes were evaluated at Katherine Research Station in the 1995-96 wet season. This information is to be the basis for a Plant Breeders Rights (PBR) application for 'Edith' (Y1:44). Provionsal PBR protection was granted for two years, 1995-97.

Major differences in phenology, capsules per leaf axil, branching habit, and seed weight could be used to identify the various genotypes. This evaluation also included 1st and 2nd generations of 'Edith' to test uniformity and stability of the genotype.

Materials and Methods

Design, treatments and management

Experimental design was a randomised complete block with 4 replications of 4 genotypes. Genotypes were Edith (1st and 2nd generation), Yori 77, Aussie Gold and Beech's Choice. Plot size was 4 rows x 7.5 m long.

The experiment was sown by a 4 row cone-seeder under zero-till conditions on the 3 January 1996. Site preparation included mulching on the 5 and 27 December and spraying with Round-up CT @ 3.0 L/ha on the 29 December. All seed was treated with Lorsban 25WC @ 160 g/100 kg seed to prevent false wire worm damage.

Plants were thinned to an intra-row spacing of 15 cm (equivalent to 133 000 plants/ha) 12 DAS.

Recordings and data collection

During the season various plant characteristics were measured. These characteristics are listed in Table 3.1.

At physiological maturity, seed yield was recorded by harvesting 1.875m^2 quadrat from the 2 middle rows. Samples were threshed, cleaned and set aside for those measurements as required in Table 3.1.

Results and Discussion

The uniformity and stability of genotype 'Edith' were demonstrated (data not presented).

Plant characteristics for sesame genotypes evaluated are presented in Table 3.2.

1. The Queensland genotypes, Aussie Gold and Beech's Choice were significantly shorter in plant stature than Edith, plus they exhibited a basal branching habit compared to the non-branching habit of Edith. Yori developed branches at the top of the plant.

2. The Qld genotypes were significantly earlier to flower and mature than the other genotypes. Edith was earlier than Yori to flower and later to mature.

3. The Qld genotypes developed longer capsules than Yori and Edith.

4. Seed length of Edith was significantly longer than the other genotypes.

Seed yield and quality

Edith and Yori produced significantly higher seed yields than the Qld genotypes (Table 3.3). Edith's seed yield was 368 kg/ha higher than that of Yori's however this was not significant. Edith developed larger seed with a higher oil content than Yori (Table 3.2).

Final description of Edith

An erect, annual variety of sesame with a non-branching habit. Stems are square in cross section, and covered with fine hairs. Leaves are broad elliptic to elliptic, covered with fine hairs, vary in degree of lobing and dentation according to position on the plant. Leaf phyllotaxy is opposite. 'Edith' has three flowers per leaf axil. Capsules are narrow oblong in shape with two carpels per capsule. Seeds are white in colour and their weight exceeds 3g/1000 seeds.

Table 3.1 Plant characteristics measured for sesame genotypes at Katherine.

Characteristic	Comment
Branching habit	At harvest
Number of branches	At harvest
Leaf length	At flowering, 6th node
Leaf width	At flowering, 6th node
Petiole length	At flowering, 6th node
Extra - floral nectaries	At flowering
Flowers per leaf axil	At flowering
Days to flower	At flowering
Days to maturity	98% capsules changed colour
Plant height at maturity	At harvest
Capsule length	After harvest
Capsule width	After harvest
Seed length	After threshing
Seed width	After threshing
1000 seed weight	After threshing
Oil content of seed	After threshing
Protein content of seed	After threshing

Table 3.2 Plant characteristics for sesame genotypes at Katherine

	Genotype			
Characteristic	Edith	Yori 77	Aussie Gold	Beech's Choice
Branching habit	non branching	top branching	basal branching	basal branching
Number of branches				
Mean	0.6	3.4	2.6	3.5
Range	4	5	6	6
Std. dev.	0.86	1.07	1.28	1.12
No. measured	100	100	100	100
Leaf length (mm)				
Mean	175.0	177.3	145.5	155.0
Range	97	95	82	75
Std. dev.	22.84	19.69	15.13	17.06
No. measured	100	100	100	100
Leaf width (mm)				
Mean	163.6	189.8	79.1	53.9
Range	145	140	63	36
Std. dev.	31.67	32.00	13.74	9.47
No. leaves measured	100	100	100	100
Petiole length (mm)				
Mean	127.7	131.9	64.3	55.1
Range	107	60	55	60
Std. dev.	21.33	13.76	10.87	12.83
No. measured	100	100	100	100
Extra-floral nectaries	rudimentary	rudimentary	developed	developed
Flowers per leaf axil	3	3	1	1
Days to flower (DAS)				
Mean	37.8	40.5	32.4	33.2
Range	16	14	8	8
Std. dev.	3.27	2.28	2.07	1.54
No. measured	100	100	100	100

Characteristic	Genotype			
	Edith	Yori 77	Aussie Gold	Beech's Choice
Days to maturity (DAS)				
Mean	96.8	93.5	83.1	89.0
Range	14	7	8	10
Std. dev.	3.82	1.34	2.28	2.73
No. measured	100	100	100	100
Plant height at maturity (cm)				
Mean	156.8	156.1	125.8	140.9
Range	65	56	75	89
Std. dev.	12.91	9.47	14.92	19.53
No. measured	100	100	100	100
Capsule length (mm)				
Mean	28.8	26.3	30.1	37.7
Range	7	9	9	12
Std. dev	1.69	1.71	1.80	2.73
No. measured	100	100	100	100
Capsule width (mm)				
Mean	8.7	8.3	9.2	8.2
Range	1	2	4	2
Std. dev.	0.45	0.49	0.65	0.49
No. measured	100	100	100	100
Seed length (mm)				
Mean	2.9	2.7	2.8	2.7
Range	0.73	1.27	1.23	0.91
Std. dev.	0.14	0.14	0.14	0.15
No. measured	400	400	400	400

Characteristic	Genotype			
	Edith	Yori 77	Aussie Gold	Beech's Choice
Seed width (mm)				
Mean	1.8	1.8	1.8	1.7
Range	0.55	0.73	0.73	0.77
Std. dev.	0.10	0.10	0.11	0.13
No. measured	400	400	400	400
Weight of 1000 seeds (g)	3.42	3.01	3.56	3.01
Oil content of seed (%)	53.6	51.4	44.2	50.3
Protein content of seed (%)	19.4	24.4	25.6	24.4

Table 3.3 Seed yield for sesame genotypes at Katherine

	Genotype			
	Edith	Yori 77	Aussie Gold	Beech's Choice
Seed yield (kg/ha)	2502	2138	1634	1554
LSD (5%) = 478.9				

4. Effect of time of sowing on sesame seed yield and yield components

Introduction

Recent times has seen the adoption of Edith as the new sesame cultivar in the Northern Territory. Previous research indicated that Edith flowered 3 days earlier than Yori while maturing 3 days later. This suggested that there was an opportunity to sow Edith earlier than the recommended sowing date for Yori. The recommended optimum sowing window for Yori at Katherine is between 7 and 14 January. This is a comprise between high seed yield and high seed quality. Sowing on the 7 January results in the crop maturing in April when the probability of rainfall is low. Median rainfall for April in Katherine is 10 mm.

This experiment investigates the effect of sowing date on seed yield and yield components on two sesame cultivars sown in Katherine, Northern Territory.

Materials and Methods

Design, treatments and management

Experimental design was a split plot with 5 sowing dates (main plot), 2 sesame genotypes (sub plots) and 3 replications. Plot size was 7.5 m x 4 rows at 50 cm row spacing.

Plots were sown zero till on the 12 December '95, 27 December '95, 9 January' 96, 23 January '96 and 6 February '96. The genotypes were Yori 77 and Edith. Plants were thinned to an intra-row spacing of 15 cm (equivalent to 133 000 plants/ha) at 14 DAS.

Recordings and data collection

During the season phenological data was recorded. This included date of seedling emergence, date to first flower, 50% plants flowering, and physiological maturity (95% capsules yellow).

Leaf area, leaf weight, stem and capsule + seed weight were measured on two plants from each plot on a weekly basis starting 3 weeks after sowing and finishing 11 weeks later. Concurrently light interception measurements was recorded at 3 locations in each plot. Results of this data will be modelled and presented in a future paper.

At physiological maturity (PM), 5 plants were selected from the end of central rows for yield component analysis. The following were recorded:

a) Capsule number per plant
b) Seed weight per plant
c) 1000 seed weight

A further 20 plants were selected to determine total plant biomass and seed weight. From this data, harvest index and seed number per capsule were calculated.

Approximately 7 days after PM potential seed yield was recorded by harvesting a 1.875 m^2 quadrat from each plot. Seed was threshed and cleaned set aside for oil and nitrogen content determinations.

Results and Discussion

Emergence
Results are presented in Table 4.1.

For the first 4 DAS, four to six percentage more Yori seedlings emerge than Edith. Generally in both cultivars the odd seedling can be found at 2 DAS, 60 to 80% of seedlings will have emerged at 3 DAS, rapidly increasing to greater than 95% of seedlings emerged by 5 DAS.

Phenology
Results are presented in Table 4.2.

Regardless of sowing date Edith produced its first flower within 31-32 DAS while 50 % of plants will have flowered by 34 DAS. Similarly Yori produced its first flower at 35-36 DAS and 50% of plants flowered by 38 DAS. Time to reach physiological maturity was shorter for both cultivars for the 23 January and 6 February sowing dates. This was probably the result of crop senescence being accelerated by plants lodging after the April storms.

Seed yield
Earlier sowing dates were generally associated with higher seed yields (Table 4.3).

The optimum sowing date for maximum seed yield for each cultivar was different. For Edith, maximum seed yield was produced with a 12 December sowing. However, if a commercial sesame crop of Edith were sown, harvesting would be in late March. The ability to harvest and seed quality would be compromised by the likelihood of rain. The next optimum date of sowing for maximum seed yield was 9 January. Generally seed quality and the ability to harvest would not be affected by rainfall. Later sowing dates produced lower seed yields, and if the crop was grown with irrigation resulted in the crop being susceptible to lodging with the end of wet season gusty storms (Table 4.2). The seed yield of Edith was reduced by half by allowing the sowing date to 'slip' from 9 January to 6 February.

For Yori, maximum seed yield was produced with a 27 December sowing. This is also too early if seed quality and ability to harvest are not to be compromised. Seed yield is reduced for later sowing dates while potential seed yield of Yori was always less than that of Edith. For the 9 January the difference in seed yield is 499 kg/ha in favour of Edith. There was only a slight difference in potential seed yield for a 6 February sowing date.

Delaying sowing past the optimum date reduced potential seed yield by 47 kg/day and 38 kg/day for Edith and Yori respectively.

Yield components

Results are presented in Tables 4.4, 4.5, 4.6, 4.7, 4.8 and 4.9.

Sowing dates for maximum seed yield for Edith (9 January) and Yori (27 December) coincided with maximum harvest indices, greatest numbers of capsules, number of seed per capsule and individual seed weights for each cultivar.

Edith produced the higher harvest index and the lowest number of capsules per plant. Seed number per capsule and seed size was also greater for Edith.

Oil content of Yori seed was higher than that of Edith seed. Both cultivars had oil contents greater than 50 %. Nitrogen and oil content in sesame are inversely related. Nitrogen content was lower in Yori than Edith seed.

Conclusion

The recommended optimum sowing window for Yori at Katherine is between 7 and 14 January. This is a comprise between high seed yield and high seed quality. Sowing Yori on the 7 January results in the sesame crop maturing in April when the probability of rainfall is low. Sowing Edith three days earlier (4 January) would result in this cultivar experiencing similar rainfall conditions as Yori as the crop matures. The newly recommended optimum sowing window for Edith at Katherine is between 4 and 14 January. Sowing earlier than the 9 January is better than sowing after the 9 January if potential seed yield is to be maximised.

Table 4.1 Percentage of seedling emerged during the first six days after sowing

Days after sowing								
Cultivar	Sowing date[1]	0	1	2	3	4	5	6
Yori 77								
	12 Dec '95	0	0	6	71	99	100	100
	27 Dec '95	0	0	0	84	90	96	100
	9 Jan '96	0	0	0	90	100	100	100
	23 Jan '96	0	0	0	65	88	94	100
	6 Feb '96	0	0	0	75	89	94	100
	Mean	*0*	*0*	*1*	*77*	*91*	*97*	*100*
Edith								
	12 Dec '95	0	0	6	73	99	100	100
	27 Dec '95	0	0	0	35	76	93	100
	9 Jan '96	0	0	0	56	85	100	100
	23 Jan '96	0	0	0	77	89	95	100
	6 Feb '96	0	0	0	84	86	94	100
	Mean	*0*	*0*	*1*	*65*	*87*	*96*	*100*

[1] mean for 3 replications

Table 4.2 Effect of time of sowing on sesame phenology at Katherine

Cultivar	Sowing date	Days after sowing: First flower	50% plants flowering	PM[1]	Comments
Edith					
	12 Dec '95	32	34	97	
	27 Dec '95	35	36	102	
	9 Jan '96	32	34	98	
	23 Jan '96	31	34	90	minor lodging
	6 Feb '96	31	34	92	severe lodging
Range		*31-35*	*34-36*	*90-102*	
Yori 77					
	12 Dec '95	36	38	97	
	27 Dec '95	36	38	96	
	9 Jan '96	37	40	92	minor lodging
	23 Jan '96	35	38	94	severe lodging
	6 Feb '96	35	37	87	severe lodging
Range		*35-37*	*37-40*	*87-97*	

[1] PM = Physiological maturity

Table 4.3 Effect of time of sowing on sesame seed yield at Katherine

Seed yield (kg/ha)	Time of sowing					
Cultivar	12 Dec '95	27 Dec '95	9 Jan '96	23 Jan '96	6 Feb '96	*Mean*
Edith	2745	2286	2559	2017	1233	*2168*
Yori	2477	2767	2060	1661	1226	*2038*
Mean	*2611*	*2526*	*2309*	*1839*	*1230*	

TOS LSD (5%) = 182.4
CULT LSD (5%) = 139.5

Table 4.4 Effect of time of sowing on sesame harvest index at Katherine

Harvest index	Time of sowing					
Cultivar	12 Dec '95	27 Dec '95	9 Jan '96	23 Jan '96	6 Feb '96	*Mean*
Edith	30.7	32.9	35.6	33.8	26.9	*31.9*
Yori	30.2	33.5	27.0	26.1	27.5	*28.9*
Mean	*30.4*	*33.2*	*31.3*	*30.0*	*27.2*	

TOS LSD (5%) = 1.95
CULT LSD (5%) = 1.13

Table 4.5 Effect of time of sowing on sesame capsule number per plant at Katherine

Capsule number	Time of sowing					
Cultivar	12 Dec '95	27 Dec '95	9 Jan '96	23 Jan '96	6 Feb '96	*Mean*
Edith	110	90	90	81	75	*89*
Yori	148	185	136	108	96	*135*
Mean	*129*	*138*	*113*	*95*	*86*	

TOS LSD (5%) = 19.2
CULT LSD (5%) = 16.7

Table 4.6 Effect of time of sowing on number of seed per capsule at Katherine

Seed/capsule	Time of sowing					
Cultivar	12 Dec '95	27 Dec '95	9 Jan '96	23 Jan '96	6 Feb '96	*Mean*
Edith	50	47	58	58	40	*51*
Yori	38	45	38	43	40	*41*
Mean	*44*	*47*	*48*	*50*	*40*	

TOS LSD (5%) = 10.0
CULT LSD (5%) = 3.5

Table 4.7 Effect of time of sowing on sesame seed size at Katherine

1000 seed weight (g)	Time of sowing					
Cultivar	12 Dec '95	27 Dec '95	9 Jan '96	23 Jan '96	6 Feb '96	*Mean*
Edith	3.61	3.45	3.67	3.32	3.48	*3.51*
Yori	3.10	3.17	2.96	2.84	2.98	*3.01*
Mean	*3.36*	*3.31*	*3.32*	*3.08*	*3.23*	

TOS LSD (5%) = 0.088
CULT LSD (5%) = 0.193

Table 4.8 Effect of time of sowing on oil content of sesame seed at Katherine

Oil content (%)	Time of sowing					
Cultivar	12 Dec '95	27 Dec '95	9 Jan '96	23 Jan '96	6 Feb '96	*Mean*
Edith	52.2	50.7	52.1	52.4	51.8	*51.8*
Yori	56.2	49.5	57.9	53.9	54.9	*54.5*
Mean	*54.2*	*50.1*	*55.0*	*53.2*	*53.4*	

Table 4.9 Effect of time of sowing on nitrogen content of sesame seed at Katherine

Nitrogen content (%)	Time of sowing					
Cultivar	12 Dec '95	27 Dec '95	9 Jan '96	23 Jan '96	6 Feb '96	*Mean*
Edith	3.5	3.6	3.5	3.4	3.9	*3.6*
Yori	3.0	3.4	3.2	3.1	3.2	*3.2*
Mean	*3.3*	*3.5*	*3.4*	*3.3*	*3.6*	