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SESAME RESEARCH REPORT 1991-92 WET SEASON KATHERINE

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1991-92 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.

CONTENTS

1. INTRODUCTION

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.

Three projects were implemented to provide farmers with commercial guidelines to sesame management and to develop a new genotype for the Northern Territory. Two of these projects were investigated jointly; Mr C Martin with 'Evaluation of chemical weed control in sesame' and Mr K Thiagalingam with 'Growth, mineral composition and seed yield of sesame as affected by boron',

ACKNOWLEDGMENTS

I thank Mr. D. Beech (CSIRO) for his advice and encouragement with the selection of the new sesame genotype for northern Australia. Mr. D. Hansen and Mr. A. Simonato are acknowledged for testing sesame seedling vigour and Miss D.Napier for technical assistance.

2. GENERAL METHODS

2.1 *Sites and Soils*

This year's experiments were undertaken at Katherine Research Station (14° 28'S, 132° 18'E), Douglas Daly Research Farm (13° 51'S, 132° 12'E), and Western Creek Station (15° 35'S, 133° 13'E). The soil type used at Katherine was a Fenton clay loam, (Lucas *et al.* 1985) while a Venn sandy loam was used at Douglas Daly and a Oolloo clay loam at Western Creek Station (Table 2.1).

2.2 *Seasonal Conditions*

At all sites, the 1991-92 season was characterised by very poor land preparation rains in November and December. In January the lack of suitable rainfall events for sowing sesame meant that the experiments were established with irrigation at Douglas Daly and Katherine. The Larrimah site was not sown. Average rainfall figures were recorded for February and well below average rainfall for the rest of the wet season. Total rainfall at Douglas Daly, Katherine and Western Creek was 850, 623 and 350 mm respectively (Table 2.2).

2.3 *Land Preparation and Weed Control*

All sites were conventionally prepared in December, while any weed regrowth was controlled with an application of Round-up CT® @ 2.0 L/ha.

Katherine site

Genotype experiment. Dual® @ 1.2 L/ha and Round-up CT @ 2.0 L/ha were sprayed on 11 January and 12 January respectively. Herbicide experiment. Round-up CT @ 2.0 L/ha was sprayed on 13 January. Soil physical conditions were dry and crumbly.

Douglas Daly

No herbicides were applied, and weed control was maintained by hand in the Genotype experiment.

2.4 *Fertiliser Application*

Katherine site

The research areas were fertilised with a basal application of single-superphosphate plus zinc, copper and molybdenum @ 216 kg/ha (approx. 18 kg P/ha, 2.2 kg Zn/ha, 2.2 kg Cu/ha and 0.05 kg Mo/ha), on 27 December 1991.

Urea was incorporated @ 78 kg/ha (approx. 36 kg N/ha) on 3 January. The experiments were top dressed with sulphate of ammonia @ 195 kg/ha (approx 40 kg N/ha) on the 10 February.

Douglas Daly site

Research areas were fertilised with single-superphosphate plus trace elements at a similar rate to Katherine, on the 8 January 1992. Urea was also incorporated @ 130 kg/ha (approx. 60 kg N/ha) on the same day. The area was side dressed (not incorporated) with sulphate of ammonia @ 20 kg N/ha on the 11 February.

2.5 *Insect Control*

Oncocoris hackeri beetles were sprayed three times during January and February with the insecticide endosulphan @ 2.0L/ha at Katherine.

Table 2.1 Soil nutrient status at Katherine, Western Creek Station and Douglas Daly

Soil analysis (0-15cm)	**Katherine**	**Western Creek Station**	**Douglas Daly**
Cond (ms/cm)	0.13	0.05	0.04
pH	7.1	5.9	7.3
Avail. P (ppm)	16	12	21
Avail. K (ppm)	365	145	46
Avail. Ca (ppm)	1800	370	470
Avail. Mg (ppm)	375	50	69
Avail. S (ppm)	8	5	2
Avail. Cu (ppm)	3.5	1.2	1.0
Avail. Zn (ppm)	1.5	2.9	2.2
Avail. Mn (ppm)	4.6	9	10
Avail. B (ppm)	0.2	0.1	<0.1
Total N (%)	0.11	0.04	0.03

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

	Nov	Dec	Jan	Feb	Mar	Apr	May	
Monthly Rainfall (mm)								**Total**
Douglas Daly	39.2	80.1	210.1a	357.9	134.8	22.6	5.4	850.1
Katherine	106.2	97.5	77.4b	248.8	56.8	13.9	22.8	623.4
Western Creek	6.7	4.8	102	109	29	0	0	350
Mean (1)	108.5	142.9	269.2	303.2	253.6	46.6	7.5	1131.5
Mean (2)	83.3	191.6	228.6	210.2	162.7	32.8	5.1	914.3
Mean (3)	63	115	205	186	149	32	12	762.0
Mean Maximum Daily Temperature (^0C)								
Douglas Daly	37.3	41.1	38.2	36.7	35.0	33.6	34.4	
Katherine	37.6	37.7	37.5	33.3	35.9	34.9	34.0	
Larrimah	37.5	38.5	37.8	35.3	36.8	34.6	32.9	
Mean (1)	36.6	35.3	33.6	32.9	33.2	33.4	32.0	
Mean (2)	37.8	36.2	34.6	34.1	34.3	33.9	32.0	
Mean (3)	38.0	37.1	35.6	34.6	34.0	33.9	31.7	
Mean Minimum Daily temperature (^0C)								
Douglas Daly	23.9	22.6	22.6	22.6	23.1	21.7	19.7	
Katherine	24.8	24.1	23.9	23.8	23.0	21.0	18.8	
Larrimah	24.5	23.9	23.4	24.0	23.4	21.0	20.0	
Mean (1)	24.2	24.0	23.7	23.7	23.0	20.6	17.1	
Mean (2)	24.3	23.9	23.7	23.4	22.3	19.5	16.2	
Mean (3)	24.4	24.5	24.1	23.7	22.7	19.8	16.6	
Mean Daily Radiation (MJ/m^2)								
Douglas Daly	28.5	17.7*	18.6*	13.7*	11.4	24.9	25.7	
Katherine	23.3	25.7	25.3	20.0	24.1	19.3	19.0	
Larrimah	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A	
Mean (1)	24.5	24.2	22.4	21.4	21.7	22.6	21.1	
Mean (2)	24.6	24.2	21.9	22.5	21.7	21.7	22.0	
Mean (3)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A	
Mean Monthly Evaporation (mm)								
Douglas Daly	259	198	190	133	94*	220	223	
Katherine	244	*	*	153	181	170	174	
Larrimah	N.A.	212	230	N.A.	N.A.	N.A.	N.A	
		N.A.	N.A.					
Mean (1)	252	226	168	146	N.A.	231	208	
Mean (2)	275	242	194	156	173	186	180	
Mean (3)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A	

* estimate - as some valves were missing
N.A. Not available
(1) Douglas Daly (2) Katherine (3) Larrimah
(a) does not include 48mm of irrigation
(b) does not include 65mm of irrigation

♦ ♦ ♦

3. Evaluation of sesame genotypes in the 1991-92 wet season

Abstract

A range of sesame genotypes were evaluated at Douglas Daly and Katherine in the 1991-92 wet season. All genotypes had produced their first flower by 36 days, and reached physiological maturity by 107 days. Genotypes matured at Katherine approximately 14 days earlier than those at Douglas Daly.

Highest seed yields were recorded by selections Y1:44 (2397 kg/ha) and Y5:83 (2298 kg/ha) at Douglas Daly and PA:40 (1757 kg/ha) and Y5:83 (1715 kg/ha) at Katherine. All selections at both sites produced higher seed yields than Yori 77.

Introduction

Sesame is considered a potential crop in the semi-arid tropics of north west Australia. Extensive genotype evaluations were undertaken in the Ord River Irrigation Area (ORIA) during the 1981-83 wet seasons. The best material from ORIA were evaluated in the Northern Territory in 1986-87 wet season. Three cultivars indicated potential suitability for the Katherine region. These were Hnan Dun, Yori 77 and Pachequino.

Since then further introductions from the University of Western Australia have been tested against Yori 77 for potential seed yield, seed quality and resistance to shattering.

Generally, characteristics of the sesame ideotype considered suitable for growing in the Northern Territory include;

a) Maturity by late April for crops planted in early January.

b) Tolerance to sesame leaf roller, *Antigastra catalaunalis*.

c) Tolerance of diseases, *Corynespora cassiicola* and *Cercospora sesamicola*.

d) Grow no taller than 1.5 m, set capsules from approximately 50 cm above the ground and develop 2 branches.

e) Capsules should be long and narrow, though not crowded on the central stem or branches, while the apex gap of capsules should be narrow.

f) The seed should be large, white and have a high oil content. The seed must not have a bitter taste.

Materials and Methods

Design, treatments and management :

Experimental design was a randomised complete block with 4 replications of 9 genotypes. Genotypes were Hnan Dun, Yori 77, Pachequino, YA:69, Y1:44, Y5:83, PA:45, PB:64 and PA:40. Plot size was 8 rows x 5.0 m, row spacing was 32 cm.

The experiment was sown by hand at both sites. The sites and dates of sowing as follows;

- Douglas Daly Research Farm - 10 January 1992
- Katherine Research Farm - 11 January 1992

Plants were thinned to an intra-row spacing of 10 cm (equivalent to 300,000 plants/ha).

Irrigation was applied at both sites to ensure plant establishment. At Douglas Daly, 23 mm of irrigation as applied on 10 January (0 DAS) and 25 mm on 17 January (6 DAS). At Katherine, 20 mm of irrigation was applied on 12 January (1 DAS) and 15 January (4 DAS), and 25 mm was applied on 20 January (9 DAS).

Recordings and Data Collection

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

At Katherine, plant height, leaf number, leaf area and plant weight were measured on 2 plants from each plot at 50% plants flowering and completion of flowering.

At physiological maturity, 7 plants were selected from the end of the centre row from each plot for yield component analysis. The following were recorded;

a) Plant height
b) Height of lowest capsule
c) Number of branches
d) Node of lowest flower scar
e) Node of lowest capsule
f) Node of lowest branch
g) Number of capsules on central stem
h) Number of capsules on branches
i) Capsule length (middle third reproductive stem)
j) Capsule width (middle third reproductive stem)
k) Apex gap of capsule
l) Oven dry stem weight
m) Oven dry capsule weight
n) Oven dry seed weight

From this data, harvest index and seed weight/total capsule weight rates were calculated. All characteristics were scored on a scale of 0 to 10. Various characteristics were given a positive or negative weighing, according to their importance. Genotypes with the highest scores will be tested further, the rest discarded.

At maturity, plant population and seed yield were recorded by harvesting 3.0m from the central 6 rows of each plot. Samples were threshed and cleaned, sub-samples were set aside of 1000 seed weight, seed colour, seed palatability, seedling vigour, % oil and % N and germination determinations.

Results

Phenology

All genotypes at Douglas Daly (DD) and Katherine (KT) produces their first flower between 28 and 36 DAS, 50% plants were flowering between 39 and 44 DAS, with completion of flowering between 67 and 82 DAS (Table 3.1).

At Douglas Daly, Hnan Dun, YA:69 and Yori 77 were earliest to reach physiological maturity (98-99 DAS) and PA:45, PA:40 and Pachequino were the latest at 107 DAS.

Genotypes at Katherine reached physiological maturity approximately 14 days earlier than Douglas Daly. Yori 77 and YA:69 were the earliest to reach physiological maturity at 85 and 86 DAS respectively, while Y1:44 and Pachequino were the latest at 93 DAS.

Morphology at 50% plants flowering at Katherine

Hnan Dun produced the shortest plant height (84.3 cm) and PA:40 the tallest height (99.3 cm). There was no significant difference between genotypes in leaf number, leaf area and plant weight. Mean leaf number, leaf area and plant weight was 59.9, 190.1 cm^2 and 150 g respectively (Table 3.2).

Morphology at completion of flowering at Katherine

At this growth stage YA:69 produced the shortest plant height (140.8 cm) and Pachequino the tallest height (164.4 cm). There was no significant difference in leaf number, leaf area and plant weight between genotypes.

During the 29 days between 50% plants flowering and completion of flowering, mean leaf number increased from 59.9 to 81.1, mean leaf area decreased from 190.1 cm^2 to 160.3 cm^2, and plant weight increased from 15.0 g to 42.4 g (Table 3.2).

The decrease in leaf area is associated in the change in leaf design as sesame flowers. Large broad leaves are found below the reproductive stem while long thin leaves are found attached to the reproductive section of the stem. As sesame flowers it develops a larger number of narrow leaves as the broader lower leaves senescence.

Plant population

Mean populations of the genotypes at Douglas Daly and Katherine were 251 and 243 x 10^3 plants/ha respectively (Table 3.3). Though there was a significant difference in genotype populations at Douglas Daly plant numbers were between 200 and 400 x 10^3 plants/ha, it is within the range that plants are able to compensate in seed yield for variations in plant population.

Potential seed yield

Mean seed yield for genotypes at Douglas Daly and Katherine were 2059 and 1484 kg/ha respectively (Table 3.3). Highest seed yields were recorded for Y1:44 (2397 kg/ha) and Y5:83 (2298 kg/ha) at Douglas Daly and PA:40 (1757 kg/ha) and Y5:83 (1715 kg/ha) at Katherine. Lowest seed yield were recorded for Yori 77 at Douglas Daly and Katherine, 1684 kg/ha and 1029 kg/ha respectively.

Yield components

Plant height.

At Douglas Daly, YA:69 was the shortest in stature (127.7 cm). Only Pachequino was so tall (>150 cm) as to make mechanical harvesting difficult (Table 3.4). At Katherine, the only genotype shorter than 150 cm was Yori 77 (Table 3.6).

Height of lowest capsule

At both sites none of the genotypes developed capsules at what is considered optimum height for the lowest capsule. Optimum height is 30 cm which is sufficiently high for insertion of the harvester's cutter bar. All genotypes produces capsules at 70 cm or greater (Table 3.4 and 3.6).

Branching habit

Hnan Dun, YA:69 and Yori 77 exhibited branching habit (Table 3.4 and 3.6), while the remaining genotypes were characterised as single-stem types. Branching is a desired characteristic for high seed yield and compactness of maturity characteristic with the optimum number of branches being 2 per plant.

Node of lowest flower scar and capsule

All genotypes at both sites had aborted their first flowers/capsules. This was probably due to the combination of high air temperatures (>35°C), high evaporation (>6.0 mm/day) and lack of soil moisture, associated with no rainfall for the previous week. The difference in node position of successful capsule set was greatest in single stem types. The general difference between the node of the lowest flower scar and the node of the first capsule was approximately 1.5 (Table 3.4 and 3.6). Genotypes which set capsules at a lower node number, as long as the height of the lowest capsule is greater than 30 cm, have a more desirable plant structure.

Node of lowest branch

All genotypes that produced a branch, developed that branch below the lowest capsule on the central stem (Table 3.5 and 3.7). Genotypes that develop branches at the top of the central stem tend to be very late maturing (>140 days) and therefore unsuitable for the Northern Territory.

Number of capsules on central stem/branches

Generally single stem genotypes produce more capsules on the central stem than branching types and vice versa. However, both Yori 77 and YA:69 (both branching types) developed large numbers of capsules on the central stem (>55 capsules/central stem) as well as on branches (Table 3.5 and 3.7).

Capsule length

Hnan Dun developed the longest capsules while YA:69 developed the shortest, 29 and 24 mm respectively (Table 3.5 and 3.7). (Note, the percentage of seed lost from long capsules should be less than that from shorter capsules if the apex gap of the capsule is similar).

Capsule width

Y5:83 developed the widest capsule width while YA:69 and Yori 77 generally had the narrowest capsule width (Table 3.5 and 3.7). Capsule width in relation to seed size is important. The narrower the capsule width or the larger the seed size in relation to each other the 'tighter' the fit of seed inside the capsule. This tends to reduce the likelihood for seed to scatter with disturbance of the plant (Table 3.10).

Pachequino had the poorest ratio ('loose' seed arrangement), while Hnan Dun the best ratio or tight seed arrangement. (Note, this is the reverse of last year's observation).

Apex gap of capsule

The larger the apex gap of the dehisced capsule the greater the seed loss when the plant is disturbed. Pachequino capsules generally had the smallest apex gap while YA:69 capsules generally had the largest apex gap, means of 7.5 mm and 9.5 mm respectively (Table 3.5 and 3.7)

Seed germination at harvest

All genotypes except Yori 77 and YA:69 contain a high proportion of fresh ungerminated seed (Table 3.8 and 3.9). The fresh ungerminated seed is an indication of the level of seed dormancy. This is a favourable characteristic to have at maturity as seed dormancy prevents seed from germinating in the capsule in the event of a late storm. As the seed ages in storage the percentage of fresh, ungerminated seed decreases. Generally by the start of the next season, there is little or no fresh ungerminated seed. The percentage of fresh ungerminated seed ranged from 47.0 to 1.0 for PB:64 and Yori 77 respectively.

Seed colour and taste

Market requirements for sesame are a white seed with no bitter taste (i.e. unpalatable). The taste of sesame seed is associated with the level of phenols and oxalic acid, normally found in the seed testa. Dark coloured seed genotypes have phenols plus a higher oxalic content than white seed genotypes. Selecting white seed genotypes avoids these phenols, however there is a considerable range of oxalic acid content within the white seed genotypes.

Yori 77 produced white seed of good taste (taken as the standard for these characteristics), while Hnan Dun produced brownish white seed of reasonable taste. YA:69 exhibited the best seed colour and taste characteristics (Table 3.8 and 3.9).

Seed oil and nitrogen content

Generally genotypes grown at Douglas Daly produce seed with a higher oil content than that of Katherine. Oil contents ranged from 54.7 to 51.7 for YA:69(DD) and Y5:83(KT) respectively. Nitrogen content of sesame seed ranged between 3.90% and 4.51% for YA:69 and Y5:83 respectively (Table 3.8 and 3.9).

Seedling radicle length at 48 hours

Seedling vigour is based on radicle length measured 48 hours after seeds have been germinated at 25°C / 12 hours - 45°C / 12 hours cycle. YA:69 produced the most vigorous seedling with a mean radicle length of 19.0 mm while Y5:83, Y1:44 and Pachequino were the slowest with a mean radicle length of 12.8 mm (Table 3.8 and 3.9).

Harvest index at maturity

Pachequino and PA:40 generally produced the highest harvest index at both sites while Hnan Dun was generally the lowest (Table 3.10). The higher the harvest index the more efficient the genotype is in partitioning assimilate to the capsules. Harvest index ranged between 28.7% and 39.9%.

Seed weight/total capsule weight ratio

Pachequino and PA:40 generally produced the highest seed weight/total capsule weight ratio, while Yori 77 the lowest (Table 3.10). The higher the seed weight/total capsule weight ratio the more efficient the genotype is in partitioning assimilate between seed and capsule wall. The seed/capsule ratio ranged between 51.0% and 58.5%.

1000 seed weight

Two genotypes, Y5:83 and Y1:44, develop large seed at both sites while Yori 77 and YA:69 produced the smallest seed. Thousand seed weight ranged between 3.96 g and 2.93 g (Table 3.11)

Susceptibility to lodging

During March 1992, both experimental sites were subjected to extensive 'knock-me-down' storms. All genotypes lodged to varying degrees. The extent of lodging was rated on a 20 point scale as follows; 0, equivalent 0% plants lodged and 20 equivalent to 100% plants lodged (Table 3.11). Both Yori 77 and YA:69 were badly lodged (65% - 97% plants lodging) while Y1:44 and PB:64 suffered minimal lodging (4% - 50% plants lodging).

Comments

All genotypes at Douglas Daly Research Farm were infected with *Corynespora cassiicola*. This disease causes 'red' lesions on stem, petioles and capsules. Some plants of Pachequino were free of these symptoms.

Hawkmoth caterpillar (*Hippotion sp.*) defoliated Hnan Dun plants in preference to the other genotypes.

Scoring

Most of the characteristics recorded were scored on a scale of 0 to 10. Various characteristics were given a positive or negative weighting according to importance. Scores ranged between 27 and 59 (Table 3.11). The higher the score the more suitable the sesame genotype for the Northern Territory.

Discussion :

The two 'highlights' of this year's research were the difference of sesame genotypes in susceptibility to lodging and the potential seed yields of the new selections.

The 1991/92 wet season was characterised as the 6th driest on record for Katherine and one of the driest on record for Douglas Daly. All genotypes produced potential seed yields greater than Yori 77 the current commercial cultivar. Seed yields were as high as 2397kg/ha for Y1:44 at Douglas Daly and 1757kg/ha for PA:40 at Katherine. However, a high potential seed yield is of no advantage if the genotype is susceptible to lodging. Both YA:69 and Yori 77 are very susceptible to lodging and for this reason YA:69 will be discarded from further evaluation. Yori 77 will remain as the commercial standard.

Three genotypes (Y1:44, Y5:83 and PB:64), have indicated high potential seed yields and good seed characteristics which make them suitable for further testing next year.

The 1992/93 season is last year of evaluating field selections.

Table 3.1 Phenology of sesame genotypes

Genotype	Days after sowing							
	First flower		50% plants flowering		Completion flowering		Physiological maturity	
	DD	KT	DD	KT	DD	KT	DD	KT
Hnan Dun	30	28	40	39	82	74	99	91
YA:69	35	34	42	40	71	67	98	86
Yori 77	36	35	41	40	71	67	99	85
Y1:44	32	31	40	40	76	70	106	93
PA:45	32	33	40	41	76	68	107	91
Y5:83	35	33	40	41	75	68	106	92
PB:64	35	34	43	41	77	69	106	92
PA:40	35	33	40	41	78	69	107	92
Pachequino	34	34	43	44	80	74	107	93
LSD (5%)	2.0	1.5	2.1	1.4	1.2	3.3	1.9	2.5

Table 3.2 Mean plant height, leaf number, leaf area and plant biomass at 50% plants flowering and completion of flowering for sesame at Katherine

	Plant height (cm)		Leaf number per plant		Leaf area (cm^2) per plant		Plant weight (g)	
Genotype	50FL[1]	CFL[2]	50FL	CFL	50FL	CFL	50FL	CFL
Hnan Dun	84.3	151.0	63.6	101.5	178.6	91.4	14.0	46.5
YA:69	91.1	140.8	60.5	92.1	187.7	141.9	13.2	30.0
Yori 77	90.1	145.6	65.8	80.6	154.9	138.3	12.0	29.3
Y1:44	91.8	155.0	79.2	75.4	233.2	159.6	17.4	43.5
PA:45	94.1	162.5	60.9	75.6	189.3	174.0	16.5	40.5
Y5:83	93.3	160.8	67.9	72.9	231.6	205.4	18.2	43.6
PB:64	91.5	157.8	46.9	79.3	183.4	186.3	15.0	46.8
PA:40	99.3	162.0	54.6	86.1	201.5	214.9	17.3	56.7
Pachequino	96.5	164.4	39.6	66.0	160.6	130.1	11.3	45.1
LSD(5%)	7.3	12.1	N.S.	N.S.	N.S.	N.S.	N.S	N.S.

[1] 50FL = 50% plants flowering
[2] CFL = completion of flowering

Table 3.3 Sesame plant populations and seed yields

	Population (x 10^3)		Seed yield (kg/ha)	
Genotype	DD	KT	DD	KT
Hnan Dun	246	250	2063	1229
YA:69	250	287	1727	1206
Yori 77	241	251	1684	1029
Y1:44	256	238	2397	1656
PA:45	286	230	2144	1693
Y5:83	239	258	2298	1715
PB:64	244	232	2288	1405
PA:40	267	221	1927	1757
Pachequino	243	222	2002	1592
Mean	251	243	2059	1484
LSD (5%)	29.0	N.S	258.2	387.9

Table 3.4 Morophology of sesame genotypes at Douglas Daly Research Farm

Genotype	Plant height (cm)	Height lowest capsule (cm)	Number of branches	Node of lowest flower scar	Node of lowest capsule
Hnan Dun	131.6	70.4	1.8	6.8	7.5
YA:69	127.7	70.8	2.4	7.5	7.7
Yori 77	130.8	71.9	2.4	7.6	8.0
Y1:44	149.0	87.1	0.0	7.0	8.6
PA:45	149.8	84.0	0.1	7.0	8.5
Y5:83	144.4	82.3	0.2	5.9	7.7
PB:64	147.0	80.2	0.0	5.8	8.9
PA:40	141.6	74.8	0.0	6.9	8.1
Pachequino	150.8	82.4	0.2	6.4	8.9
LSD (5%)	7.2	N.S.	0.49	1.10	N.S.

Table 3.5 Morophology of sesame genotypes at Douglas Daly Research Farm

Genotype	Node of lowest branch	Capsule no. (central stem)	Capsules per branch	Capsule length (mm)	Capsule width (mm)	Apex gap of capsule (mm)
Hnan Dun	5.6	35.8	15.5	29.3	5.1	9.1
YA:69	6.4	67.1	16.0	25.1	5.1	8.6
Yori 77	6.3	73.7	20.0	25.7	5.1	8.0
Y1:44	-	70.1	-	26.9	5.9	8.1
PA:45	-	74.5	-	26.9	5.8	8.3
Y5:83	-	78.1	-	26.5	5.9	8.0
PB:64	-	79.6	-	26.3	5.8	8.6
Pachequino	-	78.7	-	26.9	5.8	7.9
PA:40	-	73.8	-	26.9	5.9	8.3
LSD (5%)	-	14.78	-	1.29	0.33	N.S

Table 3.6 Morphology of sesame genotypes at Katherine Research Station

Genotype	Plant height (cm)	Height lowest capsule (cm)	Number of branches	Node of lowest flower scar	Node of lowest capsule
Hnan Dun	153.8	92.6	1.9	7.8	10.1
YA:69	153.1	85.7	1.6	7.2	8.1
Yori 77	140.2	83.9	1.2	7.5	7.9
Y1:44	153.3	101.3	0.2	7.9	9.1
PA:45	158.8	90.4	0.0	6.6	8.0
Y5:83	151.8	92.9	0.0	7.3	9.1
PB:64	154.2	86.7	0.1	7.2	9.1
PA:40	150.5	95.8	0.1	7.4	9.3
Pachequino	158.7	95.2	0.1	7.1	8.7
LSD (5%)	N.S.	N.S.	0.53	N.S.	1.13

Table 3.7 Morphology of sesame genotypes at Katherine Research Station

Genotype	Node of lowest branch	Capsule no. (central stem)	Capsules per branch	Capsule length (mm)	Capsule width (mm)	Apex gap of capsule (mm)
Hnan Dun	5.7	34.3	11.4	28.7	5.4	7.4
YA:69	7.1	80.1	14.3	23.5	5.3	10.4
Yori 77	6.7	56.4	10.9	23.5	5.3	8.4
Y1:44	-	60.1	-	26.4	5.7	7.1
PA:45	-	74.9	-	25.9	5.5	7.5
Y5:83	-	60.9	-	26.2	5.9	7.2
PB:64	-	81.8	-	26.4	5.7	7.5
PA:40	-	65.0	-	26.7	5.7	7.1
Pachequino	-	71.4	-	26.5	5.7	7.0
LSD (5%)	-	15.84	-	1.48	N.S	1.40

Table 3.8 Seed characteristics of genotypes grown at Douglas Daly Research Farm

Genotype	Germination Normal %	Fresh Ungerm	Seed colour[1]	Seed taste[2]	Oil content (%)	Seed nitrogen (%)	Radicle length (mm)
Hnan Dun	58	35	1	8	53.8	4.12	15.0
YA:69	92	2	8	3	54.7	3.90	20.0
Yori 77	80	15	4	3	54.5	3.90	18.0
Y1:44	47	46	7	6	52.6	4.22	12.6
PA:45	45	37	7	10	52.4	4.35	14.0
Y5:83	56	37	2	8	53.2	4.21	13.0
PB:64	47	47	6	5	52.4	4.42	12.0
PA:40	55	37	4	10	52.3	4.45	15.6
Pachequino	51	44	7	8	52.7	4.16	11.6

1. Seed colour: 1 = brownish white, 10 = bright white
2. Seed taste: 0 = tasteless, 15 = bitter

Table 3.9 Seed characteristics of genotypes grown at Katherine Research Station

Genotypes	Germination Normal %	Fresh ungerm.	Seed colour[1]	Seed taste[2]	Oil content (%)	Seed nitrogen (%)	Radicle length (mm)
Hnan Dun	75	19	1	3	52.4	4.39	16.0
YA:69	96	1	9	4	53.5	4.26	18.0
Yori 77	94	1	8	5	53.2	4.15	18.0
Y1:44	68	28	4	6	52.8	4.41	13.0
PA:45	65	28	4	3	52.7	4.23	12.6
Y5:83	78	17	2	11	51.7	4.51	12.6
PB:64	59	36	6	11	52.2	4.34	14.0
PA:40	66	29	5	8	52.0	4.49	12.0
Pachequino	59	37	6	8	52.7	4.38	14.0

1. Seed colour 1 - brownish white 10 = bright white
2. Seed taste 0 = tasteless 15 = bitter

Table 3.10 Harvest index at maturity, seed weight/total capsule weight ratio and capsule width versus 100 seed weight

	Harvest index (%)		Seed/capsule ratio (%)		Capsule width/100 seed weight[1]	
Genotype	DD	KT	DD	KT	DD	KT
Hnan Dun	32.1	28.7	55.4	54.5	14.3	16.7
YA:69	35.1	31.7	55.8	55.4	15.7	18.1
Yori 77	34.1	26.7	53.8	51.0	14.7	18.5
Y1:44	35.2	31.8	57.5	56.9	15.1	16.7
PA:45	33.5	33.3	55.6	55.9	15.7	16.4
Y5:83	34.3	30.7	56.0	53.7	14.8	17.1
PB:64	33.4	32.4	56.1	54.7	15.6	17.7
PA:40	39.9	33.2	57.1	57.3	15.7	17.1
Pachequino	35.8	34.5	58.5	58.0	15.9	18.1
LSD (5%)	N.S.	3.46	N.S.	N.S.	-	-

1. The lower the value the tighter the seed fit inside the capsule.

Table 3.11 Characteristics of sesame genotypes

Genotype	1000 seed weight (g) DD	KT	Lodging (rating)[1] DD	KT	Score DD	KT
Hnan Dun	3.56	3.23	12.5	5.8	59	41
YA:69	3.23	2.93	19.5	13.5	57	44
Yori 77	3.46	2.86	19.5	14.5	57	29
Y1:44	3.86	3.40	10.0	2.5	33	27
PA:45	3.66	3.36	11.0	9.5	30	32
Y5:83	3.96	3.46	12.5	3.5	37	23
PB:64	3.73	3.20	10.5	0.8	31	32
PA:40	3.76	3.33	11.5	3.8	42	32
Pachequino	3.66	3.13	10.5	2.0	36	33

1. Lodging 0 = 0% plants lodged 20 = 100% plants lodged

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4. Evaluation of sesame selections in the 1991-92 wet season

Introduction

A wide range of sesame plant types are found in commercial crops grown in the Northern Territory. This diversity provides scope for selection of better genotypes with higher yield potential and improved seed quality.

In the 1988-89 season eleven potentially improved lines were identified for inclusion in the 1989-90 evaluation of superior selections. Since then approximately eight new lines have been selected each year for inclusion in this experiment with the best 3 selections advancing to the genotype evaluation while the rest were either discarded or re-evaluated the following year. This year 10 selections were examined.

Materials and Methods

Design, treatments and management

Experimental design was a randomised complete block with 4 replicates of 10 sesame selections. The experiment was sown at Katherine on the 11 January 1992.

The selections were coded as follows; Y1:44/3, WC:1, KT:1, P3:63, H:1, H:2, H:3, H:8, H:11 and P3:S.

Plot size was 4 rows x 5.0 m with a row spacing of 32 cm. Plants were thinned to an intra-row spacing of 10 cm (equivalent to 300 000 plants/ha).

Measurements and data collection

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

Leaf number, leaf area and plant weight were measured on 2 plants from each plot at 50% plants flowering and completion of flowering.

At physiological maturity, 7 representative plants were selected from the end of each plot for yield component analysis. The following were recorded:

a) Plant height
b) Height of lowest capsule
c) Number of branches
d) Node of lowest capsule or flower scar
e) Node of lowest branch
f) Number of capsules on central stem
g) Number of capsules on branches
h) Capsule length (middle third reproductive stem)
i) Capsule width (middle third reproductive stem)
j) Apex gap of capsule
k) Oven dry stem weight
l) Oven dry capsule weight
m) Oven dry seed weight

From this data, harvest index and seed weight/total capsule weight ratio were calculated. All characteristics were scored on a scale of 0 to 10. Various characteristics were given a positive or negative weighting, according to their importance. Selections with the highest scores will be tested further, the rest discarded.

At maturity, plant population and seed yield were recorded by harvesting 2 rows x 3.0m from of each plot. Samples were threshed and cleaned, sub-samples were set aside of 1000 seed weight, seed colour, seed palatability, seedling vigour, % oil and % N determinations.

Results

Phenology

All selections produced their first flower by 39 DAS, 50% plants flowering by 44 DAS, completed flowering by 77 DAS and reached physiological maturity by 101 DAS (Table 4.1). There was a large range in the phenology of the selections.

Plant height, leaf number, leaf area and plant biomass

At 50% plants flowering

There was a wide range in plant development for the various selections. However the later flowering selections tended to be taller, have more leaves and develop a larger biomass than the earlier flowering types (Table 4.2). Mean plant height, leaf number, leaf area and plant biomass was 89.4 cm, 58, 134.4 cm^2 and 14.1 g.

At completion of flowering

For all selections leaf number increased from 50% plants flowering to completion of flowering, while leaf area generally decreased. The general decrease in leaf area is associated with the change in leaf design as the plant flowers (broad leaves to narrow leaves) and senescence of the large lower leaves. Plant biomass increased with time (Table 4.2). Mean plant height, leaf number, leaf area and plant biomass was 157.4 cm, 86, 119.2 cm^2 and 40.4 g.

Plant population

Mean selection population at harvest was 279 x 10^3 (Table 4.3). There was no significant difference in plant populations between sesame selections.

Potential seed yield

Mean sesame seed yield was 1514 kg/ha (Table 4.3). The selection H:1 produced the highest seed yield of 1839 kg/ha, while P3:S produced the lowest seed yield of 1019 kg/ha.

Lodging

There was a wide range in susceptibility of the selections to lodging. The least susceptible to lodging were H:1 and H:2 while P3:S and WC:1 were the most susceptible (Table 4.4). Percentage of plants lodged ranged from 1% to 63%.

Morphology

Morphological characteristics of the superior selections are present in Table 4.5 and 4.6.

Scoring

The three superior selections that scored the highest ratings were KT:1, P3:S and WC:1.

Discussion

The sesame ideotype suitable for the Northern Territory has been discussed in the section for genotype evaluation. Basically the plant has to grow no taller than 1.5 m, set capsules from approximately 30 cm above the ground and develop 2 branches. Capsules should be long and narrow, though not crowded on the central stem or branches, while the apex gap of the capsules should be small.

The seed produced should be large, white and high oil content (>3.5 g/1000 seed and >55% oil). The seed must not be unpalatable and produce a vigorous seedling.

The top two superior selections H:1 and H:11 (compromise between seed yield and high score) are to be further tested in the Genotype Evaluation Trial in 1992-93.

Table 4.1 Phenology of sesame selections

Selection	Days after sowing			
	First flower	**50% plants flowering**	**Completion flowering**	**Physiological maturity**
KT:1	30	36	75	93
WC:1	34	38	65	87
H:1	34	38	68	86
H:8	33	39	76	93
Y1:44/3	31	39	73	101
P3:S	35	40	71	90
H:2	34	41	73	91
H:3	34	42	77	91
P3:63	36	42	73	92
H:11	39	44	74	90
LSD (5%)	1.9	1.1	4.6	3.0

Table 4.2 Plant height, leaf number, leaf area and plant biomass of sesame selections.

Selections	Plant height (cm)		Leaf number per plant		Leaf area per plant (cm^2)		Plant biomass (g)	
	50FL[1]	**CFL[2]**	**50FL**	**CFL**	**50FL**	**CFL**	**50FL**	**CFL**
KT:1	77.5	151.1	51.8	73.9	132.7	119.5	9.2	43.7
WC:1	80.3	150.9	54.6	97.6	122.4	152.4	8.9	40.7
H:1	76.6	143.5	57.6	78.3	95.5	104.7	9.2	34.1
H:8	89.1	154.1	44.9	70.5	119.2	77.3	9.9	34.2
Y1:44/3	83.1	154.6	63.5	98.4	139.4	202.3	10.0	49.1
P3:S	90.4	150.1	74.9	78.3	168.5	130.9	14.5	34.0
H:2	95.4	169.6	48.4	106.4	117.4	124.5	12.3	46.3
H:3	109.3	176.5	70.8	84.6	133.4	68.9	14.5	40.7
P3:63	86.9	167.8	39.3	52.1	159.4	114.3	12.5	38.6
H:11	105.3	155.8	74.6	123.0	156.4	97.1	13.3	42.7
LSD (5%)	8.9	N.S.	17.8	36.8	N.S.	N.S.	3.8	N.S.

[1] 50FL = 50% plants flowering
[2] CFL = completion of flowering

Table 4.3 Sesame populations and seed yields

Selection	Plant population ($x10^3$)	Seed yield (kg/ha)
KT:1	250	1239
WC:1	292	1805
H:1	291	1839
H:8	313	1828
Y1:44/3	251	1065
P3:S	251	1019
H:2	279	1697
H:3	284	1346
P3:63	273	1576
H:11	310	1743
Mean	279	1514
LSD (5%)	N.S.	411

Table 4.4 Lodging of superior selections

Selection	Percentage of plants lodged
KT:1	46
WC:1	58
H:1	1
H:8	14
Y1:44/3	34
P3:S	63
H:2	1
H:3	24
P3:63	34
H:11	11

Table 4.5 Morphology of superior selections at Katherine

Selection	A	B	C	D	E	F	G	H	I
					Character				
KT:1	136.1	66.3	1.7	6.6	5.3	72.2	17.2	25.5	5.3
WC:1	140.9	72.5	0.8	6.8	5.7	52.4	13.0	28.5	5.4
H:1	156.9	68.7	1.3	6.4	5.7	40.4	11.4	32.1	5.4
H:8	166.3	93.1	1.0	6.8	6.2	45.0	15.0	32.4	5.2
Y1:44/3	152.4	83.9	1.3	7.3	5.9	79.2	15.2	25.1	5.3
P3:S	141.0	78.4	2.3	8.2	6.7	75.5	23.8	23.5	5.2
H:2	157.1	92.9	2.4	7.7	6.3	32.2	12.2	30.0	5.0
H:3	168.6	101.8	1.9	8.4	6.2	30.2	13.4	30.3	5.1
P3:63	161.7	93.7	0.1	6.8	4.1	68.8	6.1	25.9	5.4
H:11	166.9	109.9	2.4	8.6	6.9	33.6	12.7	29.2	5.0
LSD (5%)	14.6	10.8	0.9	1.1	1.1	15.9	N.S.	1.8	N.S.

A: Plant height (cm)
B: Height of lowest capsule (cm)
C: Number of branches
D: Node of lowest capsule/flower scar
E: Node of lowest branch
F: Number of capsules on central stem
G: Number of capsules per branch
H: Capsule length (mm)
I: Capsule width (mm)

Table 4.6 Morphology of superior selections at Katherine

Selection	J	K	L	M	N	O	P	Q	R	S
					Character					
KT:1	7.2	33.7	54.7	3.20	6	10	52.8	4.19	8.0	61
WC:1	9.1	32.9	55.0	3.36	13	4	54.5	3.95	7.8	47
H:1	7.8	31.1	54.5	3.30	4	7	55.3	3.74	4.3	46
H:8	8.5	27.2	53.3	3.53	3	1	53.5	4.26	9.5	43
Y1:44/3	7.7	28.8	51.2	2.33	3	7	52.6	4.22	9.3	43
P3:S	6.9	26.6	46.4	3.10	5	2	51.0	4.48	7.0	51
H:2	7.5	26.0	52.5	3.40	12	9	53.8	4.37	5.5	43
H:3	8.2	23.2	52.1	3.26	9	3	53.4	4.00	9.3	43
P3:63	7.0	26.8	49.4	3.13	3	7	54.0	4.25	6.5	27
H:11	7.1	25.2	52.3	2.96	3	7	52.0	4.48	9.5	43
LSD (5%)	N.S.	4.5	N.S.	-	-	-	-	-	0.6	-

J: Apex gap of capsule (mm)
K: Harvest index
L: Seed weight/total capsule weight (%)
M: 1000 Seed weight (g)
N: Taste (0 = tasteless, 20 = bitter)
O: Seed colour (1 = brownish white, 10 = white)
P: Seed oil content (%)
Q: Seed nitrogen content (%)
R: Seedling vigour (1 = slow, 10 = vigorous)
S: Score

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5. Evaluation of chemical weed control in sesame

Introduction

Weeds commonly encountered in sesame crops in the Northern Territory are summer grasses (*Brachiaria sp., Digitaria sp. and Urochloa sp.*) pigweeds (*Trianthema portulacastrum and Portulaca oleracea*) and Buffalo clover (*Alysicarpus vaginalis*). Currently sesame farmers rely on pre-sowing cultivation and herbicides for weed control. Previously the most commonly used herbicide was alachlor (Lasso®). The withdrawal of alachlor from the market initiated research into alternative herbicides. Previous research shows that Metolachlor (Dual®) and trifluralin (Treflan®) at application rates under 2.0 L/ha were known not to induce visual symptoms of damage to sesame plants and provided at least temporary control of grasses and pigweed.

As a result of these observations, a study was initiated to evaluate the effect of metolachlor and trifluralin on sesame seed yield and measure chemical residual levels in soil, sesame seed and plant material. A new herbicide, Yield® (Trifluralin/oryzalin mix), was also included in this experiment.

Materials and methods

Design, treatments and management

Experimental design was a randomised complete block with 11 herbicide treatments and 4 replications. The experiment was sown at 2 sites. The sites and dates of sowing as follows;

- Douglas Daly Research Farm - 16 January 1992
- Katherine Research Station - 14 January 1992

Treatments and levels of herbicide application are listed in Table 5.1. Conditions at time of herbicide application are presented in Table 5.2.

Plot size was 7 rows x 6.0 m with 32 cm row spacing. Sesame cv Yori 77 was sown with a small plot combine, then thinned to an intra-row spacing of 10 cm (equivalent to 300 000 plants/ha) at 14 DAS.

Recordings and data collection

Dry matter production and plant numbers were measured at sesame canopy closure, 41 DAS (KT) and 42 DAS (DD). A sample of 4 rows x 2.0 m was collected and all plant material was identified and divided into sesame, grasses, legumes and broadleaf weeds. These components were dried and weighed. A list of weed species identified is presented in Table 5.3.

At physiological maturity (86-88 DAS), sesame plant population and seed yield were recorded by harvesting 3.0 m x 4 rows. All above ground material was collected, threshed and seed cleaned. Soil samples (0-15 cm) were collected from each plot. All material (seed and soil) was then stored at 9°C until analysis for metolachlor or trifluralin residual levels. Method of analysis for metolachlor and trifluralin are presented in appendix 1.

Results

Sesame population at canopy closure

Sesame establishment was more successful at Katherine on the Fenton clay loams than on the Douglas Daly Venn, sandy clay loam. Mean sesame population was 241 x 10^3 plants/ha and 143 x 10^3 plants/ha at Katherine and Douglas Daly respectively (Table 5.4 and 5.5).

At both sites, the Hand weeded and No herbicide plots developed the highest sesame populations. Within a herbicide treatment (eg Trifluralin) the higher the level of chemical applied the greater the mortality of sesame plants.

Sesame biomass at canopy closure

At Katherine, sesame biomass for plots treated with Dual or Yield at the highest rate of chemical application was significantly less than for other treatments. All other plots had similar levels of sesame biomass. This is because sesame plants are capable of compensating for variations in plant populations between 200 and 400 x 10^3 plants/ha. Therefore it was expected that the plot treated with Yield at 6.4 L/ha (162 x 10^3 plants/ha), would have a low plant biomass.

At Douglas Daly, sesame plant population directly affected sesame biomass. Most plots had sesame populations less than 200 x 10^3 plants/ha. Generally the lower the sesame plant stand the smaller the sesame biomass.

Weed biomass at canopy closure

Grass weed biomass was higher at Katherine than Douglas Daly (Table 5.4 and 5.5). Legume and broadleaf weeds were generally evenly spread throughout the Katherine site, while broadleaf weeds were generally the only weed at Douglas Daly.

Total weed biomass was significantly reduced in plots treated with Yield at 1.6 L/ha and 3.2 L/ha. Weed biomass increased at the highest rate of Yield application because the sesame plant population was not sufficiently large enough to suppress weed growth.

Sesame population at harvest

Mean sesame plant population at Douglas Daly and Katherine was 158 x 10^3 plants/ha and 220 x 10^3 plants/ha respectively (Table 5.6). At Douglas Daly, the no herbicide and hand weeded plots had higher plant populations than the remaining treatments. At Katherine only plots treated with Dual at 4.0 L/ha or Yield at 6.4 L/ha had populations less than 200 x 10^3 plants/ha.

Seed yield

There was no significant increase in sesame seed yield as a result of weed control (Table 5.6). Mean seed yield at Douglas Daly and Katherine was 1540 kg/ha and 1249 kg/ha respectively. The greater yield at Douglas Daly reflects the higher rainfall at Douglas Daly as compared to Katherine. At both sites there was a trend for seed yields of decrease in plots receiving higher levels of Yield application.

Metolachlor residues

Soil
Metolachlor residues were detected in soil samples collected at Douglas Daly and Katherine (Table 5.7). Level of metolachlor residue was higher in the Fenton clay loams than the Venn sandy clay loams. It is expected that these residues will break down by the start of the next cropping season.

Seed
Metolachlor residues were not detected in seed samples collected at Douglas Daly and Katherine (Table 5.7).

Trifluralin residues

Soil
Trifluralin residues were detected in soil samples collected at Douglas Daly and Katherine (Table 5.8). Level of trifluralin residue was higher in the Venn sandy clay loams than the Fenton clay loam. This was probably due to the incorporation of the trifluralin treatment on the Venn soil type. (Note, the current formulation of trifluralin does not volatilise as readily as the old formulation, incorporation of trifluralin is now optional (Col Schiller - Nufarm, pers. comm.).

Seed
Trifuralin residues were detected in seed collected at both sites (Table 5.8). Seed in plots not treated with trifluralin recorded background levels of 0.009 and 0.002 for Douglas Daly and Katherine respectively. Similar residue levels were determined for all rates of trifuralin application at their respective sites.

Discussion

The application of herbicides to control weeds in sesame did not produce significant increases in sesame seed yields. However this does not mean that herbicides are not required to grow sesame. Potential seed yields were determined by hand harvesting datum areas. If the datum areas were machine harvested, seed yields would be less in weedy plots due to the weed species impeding the flow of sesame material through the harvester and prevent maximum seed recovery. Also the presence of weed seeds in the grain would down grade the quality of seed and increase cleaning (processing) costs. A further problem is the sap from the weed species which adheres to the sesame seed. This imparts a bitter taste to the seed and sesame products (e.g. paste), making the seed unsuitable for sale. Therefore weed free sesame crops are important from the seed quality aspect though significant increases in seed yield would be advantageous.

The investigation of metolachlor and trifluralin residues in soil will be finalised next year. At present no metolachlor residues have been detected in sesame seed. The 'breakdown' of metolachlor in soils with a high clay content is slower than in soils with a low clay content.

Trifluralin residues were detected in sesame seed, including treatments where no trifluralin was applied. The level of residue was 'constant' for all application rates at a particular site. Trifluralin residues were higher at Douglas Daly and Katherine indicating that incorporation was enhancing the effectivness of trifluralin.

Table 5.1 Treatments and levels of herbicide application.

Herbicide	Registered name	Level of application kg a.i./ha (L/ha)		
Trifluralin[1]	Treflan	0.40 (1 L/ha)	0.80 (2 L/ha)	1.60 (4 L/ha)
Metolachlor[2]	Dual	0.72 (1 L/ha)	1.44 (2 L/ha)	2.88 (4 L/ha)
Trifluralin/Oryzalin[3]	Yield	- (1.6 L/ha)	- (3.2 L/ha)	- (6.4 L/ha)

1. Post plant pre-emergent, not incorporated - Katherine
   Post plant pre-emergent, incorporated - Douglas Daly
2. Post plant pre-emergent, not incorporated - Katherine and Douglas Daly
3. Post plant pre-emergent, not incorporated - Katherine
   Post plant pre-emergent, incorporated - Douglas Daly

Table 5.2

Environmental conditions	Site: Douglas Daly 17 January	Site: Katherine 14 January
Soil type	Venn, sandy clay loam	Fenton, clay loam
Soil conditions	light, dry surface	dry, crumbly surface
Time of application	8.00am - 10.00am	10.30am - 12.30pm
Humidity	76%	61%
Wind speed	calm - 10km/hr	calm
Irrigation applied in	7 hours	0.5 hours
Amount of irrigation	25mm	20mm
Volume of water/ha applied with chemical	153 L/ha	153 L/ha

Table 5.3 Weed species at experimental sites

	Site	
	Katherine	Douglas Daly
Alysicarpus vaginalis	D	
Boerhavia spp.		D
Trianthema portulacastrum	D	
Tribulus terrestris		D
Urochloa mosambicensis	D	
Crotalaria goreenis	CD	
Crotalaria spp.	CD	
Sida spp.	CD	CD
Stylosanthes humilis	CD	
Tridax procumbens	CD	
Vigna spp.	CD	
Amaranthus spp.		
Brachiaria pubigera		
Centrosema pascuorum		
Cenchrus ciliaris		
Cucumis spp.		
Euphorbia hirta		
Hyptis suaveolens		
Indigofera hirsuta		
Ipormea spp.		
Macroptilium lathyroides		
Passiflora spp.		
Physalis spp.		
Portulaca oleracea		
Sesbania cannabina		
Sorghum sp		

D = dominate species **CD** = co-dominate species

Table 5.4 Effect of herbicide application on sesame plant population and weed biomass at Katherine.

Treatment	41DAS					
	Sesame plant population (x 10^3 plants/ha)	**Sesame biomass (kg/ha)**	**Grass weeds (kg/ha)**	**Legume weeds (kg/ha)**	**Broadleaf weeds (kg/ha)**	**Total weeds biomass (kg/ha)[1]**
Treflan (1 L/ha)	259	1663	54	95	99	2.39
Treflan (2 L/ha)	272	1524	26	49	53	1.99
Treflan (4 L/ha)	221	1482	11	42	126	2.06
Dual (1 L/ha)	274	1540	15	136	60	2.28
Dual (2 L/ha)	259	1534	0	109	19	1.51
Dual (4 L/ha)	210	1109	10	160	113	2.43
Yield (1.6 L/ha)	230	1307	15	109	9	1.57
Yield (3.2 L/ha)	217	1320	3	47	15	1.36
Yield (6.4 L/ha)	162	921	52	105	23	2.25
No herbicide	259	1466	58	187	111	2.51
Hand weeding	290	1657	0	0	0	0.00
Mean	241	1413	24	98	56	1.85
LSD (5%)	51.0	349.8	35.2	N.S.	N.S.	0.816

[1]. Data has been transformed log 10 (x).

Table 5.5 Effect of herbicide application on sesame plant population and weed biomass at Douglas Daly

Treatment	42DAS					
	Sesame plant population (x 10^3 plants/ha)	**Sesame biomass (kg/ha)**	**Grass weeds (kg/ha)**	**Legume weeds (kg/ha)**	**Broadleaf weeds (kg/ha)[1]**	**Total weeds biomass (kg/ha)[1]**
Treflan (1 L/ha)	100	561	1	1	3.22	3.22
Treflan (2 L/ha)	86	602	0	4	3.18	3.18
Treflan (4 L/ha)	89	592	0	2	2.49	2.50
Dual (1 L/ha)	213	1503	0	3	2.46	2.46
Dual (2 L/ha)	174	1122	0	1	2.45	2.42
Dual (4 L/ha)	145	855	0	1	2.20	2.26
Yield (1.6 L/ha)	119	816	0	1	2.99	2.99
Yield (3.2 L/ha)	113	763	0	3	2.94	2.95
Yield (6.4 L/ha)	63	436	0	0	2.87	2.87
No herbicide	230	1152	2	0	3.19	3.19
Hand weeding	247	1621	0	2	0.00	0.00
Mean	143	911	0	2	2.54	2.55
LSD (5%)	53.5	404.7	N.S.	N.S.	0.808	0.816

[1]. Data has been transformed log 10 (x).

Table 5.6 Effect of weed control on sesame plant population and seed yield.

	Plant population ($x10^3$ plants/ha)		Seed yield (kg/ha)	
Treatment	DD	KT	DD	KT
1. Treflan (1 L/ha)	121	240	1667	1383
2. Treflan (2 L/ha)	112	247	1279	1114
3. Treflan (4 L/ha)	104	227	1074	1364
4. Dual (1 L/ha)	201	260	2000	1408
5. Dual (2 L/ha)	198	238	1734	1229
6. Dual (4 L/ha)	141	176	1770	1349
7. Yield (1.6 L/ha)	122	247	1620	1358
8. Yield (3.2 L/ha)	117	219	1332	1119
9. Yield (6.4 L/ha)	83	129	1279	961
10. No herbicide	270	212	1605	1098
11. Hand weeding	245	242	1579	1334
Mean	158	220	1540	1249
LSD (5%)	64.3	49.0	N.S.	N.S.

Table 5.7 Metolachlor residue levels - mean for 4 reps.

	Site			
Treatment	Douglas Daly		Katherine	
	Soil	Seed	Soil	Seed
No herbicide	-	N/D	-	N/D
Hand weeding	N/D	N/D	N/D	N/D
Dual (1 L/ha)	0.009	N/D	0.015	N/D
Dual (2 L/ha)	0.028	N/D	0.041	N/D
Dual (4 L/ha)	0.039	N/D	0.051	N/D

N/D = not detected

Limit of determination = 0.005mg/kg (soil)
Limit of determination = 0.01mg/kg (seed)

- = not determined

Table 5.8 Trifluralin residue levels - mean for 4 reps.

Treatment	Douglas Daly		Katherine	
	Soil	Seed	Soil	Seed
No herbicide	-	0.008	-	0.002
Hand weeding	N/D	0.009	N/D	0.001
Trifluralin (1 L/ha)	0.006	0.011	0.002	0.001
Trifluralin (2 L/ha)	0.010	0.013	0.003	0.001
Trifluralin (4 L/ha)	0.036	0.011	0.015	0.001

Site: Douglas Daly, Katherine

N/D = not detected

\- = not determined

Limit of detection = 0.002mg/kg (soil)
Limit of detection = 0.001 mg/kg (seed)

♦ ♦ ♦

6. Growth, mineral composition and seed yield of sesame as affected by boron.

1. Introduction

The Venn sandy clay loam is a major soil type in the Daly Basin of the NT. Sesame prefers these well drained soils, however the Venn soils are very low in boron. For most crops, boron deficiency results in any of the following;

(a) growing points die
(b) stems crack or are hollow and brittle
(c) seed set is affected.

Though visual boron deficiency symptoms have not been identified in a sesame crop in the N.T. plant analysis did indicate boron deficiency. This project investigates sesame response to boron application.

2. Materials and method

Design, treatments and management

Virgin Venn sandy clay loam was collected from the area known as the Blain Block at the Katherine Research Station. All soil was from the surface 15cm and the soil analysis is shown in Table 6.1.

Experimental design was a latin square with 5 levels of boron application and 5 replications.

The levels of boron (laboratory grade Boric acid) were 0, 1.0, 2.0, 3.0 and 4.0 mg B/kg soil. Details of basal fertiliser used for the pots are shown in Table 6.2. All chemicals were mixed with 20 kg of soil per pot before sowing.

The experiment was sown on 18 November 1991 in the greenhouse at Katherine Research Station. Ten seeds cv Yori 77, were sown in each pot. Seed analysis is presented in Table 6.3. After establishment (8 DAS) plants were thinned to 2 per pot, (seedlings were discarded outside the pot). Pots were generally rainfed, though they received supplementary water each day to avoid any visible signs of water stress (approx. 60 L of water during the experiment). Water analysis is presented in Table 6.3.

Recordings and data collection

During the experiment plants were assessed for visual symptoms of boron deficiency or toxicity.

At physiological maturity (98 DAS), plants (including roots) were harvested. Capsules were partitioned into top, middle and bottom third of reproductive stem and branches. The following were measured on the plants: plant height, shoot and root weight, number of capsules and seed weight per plant. Seed number per capsule and 300 seed weight were determined for each partition of the reproductive stem. Seed from each replication was combined for boron content determinations.

Results

Boron toxicity symptoms

Boron toxicity symptoms were identified in pots receiving 2 mg B/kg soil or greater. The severity of symptoms increased with the higher level of treatment (Table 6.4).

Yield components

Plant height and biomass

Sesame plant height and biomass were significantly depressed by boron applications greater than 1 mg B/kg soil (Table 6.5). Plant height was depressed from 141.6 cm to 123.6 cm, and plant weight was depressed from 33.4 g to 21.9 g.

Capsule number

Capsule number per plant was significantly depressed by boron applications greater than 1mg B/kg soil (Table 6.5). The decrease in capsule number for the range of boron treatments can be defined as:
capsule number = -5.62* rate of boron application + 81.06
(Note though capsule number increased for an application of 1 mg B/kg of soil, this was not significant).

Seed weight

Seed weight per plant reflected capsule number per plant. There was a trend for seed weight to increase for an application of 1 mg B/kg soil then decrease at higher levels of boron application. The correlation between capsule number and seed weight was 90.6%. Seed weight was only significantly different between the 1 mg B/kg soil and the 4 mg B/kg soil treatments (Table 6.5).

Shoot/root ratio

Shoot/root ratio significantly increased for the 3 and 4 mg B/kg soil treatments (Table 6.5). The increase in shoot/ratio was a result of the large decrease in root development at the higher rates of boron application.

Partitioning of 300 seed weight

Seed size increased from top to bottom of sesame plants. Branches produced seed of similar size to that found in capsules of the bottom third of the reproductive stem (Table 6.6). Significant increases in seed size were found in the middle and bottom thirds of reproductive stem for the highest levels of boron application. The increases in seed size may have been as a result of the plant compensating for the reduction in capsule number.

Partitioning of seed number per capsule

There was no significant changes in seed number per capsule for any of the boron treatments at any position on the sesame plant (Table 6.7). Mean seed number per capsule (large bold seed) was 38.

Partitioning of seed weight per plant

There was not significant difference in seed weight for the various partitions for any boron treatments (Table 6.8).

Boron uptake by sesame seed

Boron uptake by sesame seed increased dramatically for an application of 1 mg B/kg soil (Table 6.9). There was no further increase in boron uptake for higher levels of boron applications. For the highest treatment boron uptake decreased.

Discussion

This experiment investigated the response of sesame to applications of boron. Sesame develop toxicity symptoms on the lower leaves for boron applications greater than 1 mg/kg soil. Toxic levels of boron caused necrosis at leaf margin, as symptoms intensified the necrosis became interveinal and the leaves turned pale yellow. Severe toxicity cause premature abscision of the leaf.

There was no significant increase in seed yield per plant, seed size or seed number per capsule for an application of 1 mg B/kg soil. However the author believes that the trend for an increase in seed yield and seed size for the lowest level of boron application requires further research.

There have been suggestions that the level of boron in the bore water influenced the experiment. During the experiment approximately 60 L of bore water per pot were used to maintain soil moisture. A preliminary calculation indicates that this is equivalent to applying 7.2×10^{-2} mg B/kg soil. It is believed that these levels are insignificant when compared to the boron treatment levels used in this experiment.

The use of bore water to maintain soil moisture caused the addition of calcium (in water) which would affect boron uptake. Various authors have identified that 'under alkaline conditions, boron may be tied up with calcium and this reduces its availability. A decreased uptake of boron with increased soil pH has been found in various crops'. Soil analysis at the completion of the experiment indicated that soil pH had increased uniformly across all treatments. Even with the increase in soil pH (decreased availability of boron) sesame developed toxicity symptoms on the lower leaves. This would suggest that boron toxicity may have been identified at lower levels of application if the soil pH had not been increased.

The author also believes that the transition between boron deficiency - sufficiency - toxicity has a very narrow range for sesame, and the difference between any of these levels is affected by soil pH and availability of calcium, potassium and possibly phosphorus. (Note, sesame genotypes may also vary for their boron response). It is desirable that these experiments can be repeated using distilled or rain water, correcting the problems of bore water being used. There is a need to investigate the interaction of boron with calcium and potassium or phosphorous using sesame as the crop. (Note, In glasshouse experiments with boron many plant nutritionist's use double de-ionised water that was passed through a column of boron specific resin to remove boron impurities). The treatment levels in the new experiment should be between 0 mg B/kg soil and 2 mg B/kg soil.

Table 6.1 Soil analysis

	Virgin Venn
pH	6.5 (8.2)[1]
Conductivity (ms/cm)	0.03
P (ppm)	3
K (ppm)	23
Ca (ppm)	425
Mg (ppm)	47
S (ppm)	1
Cu (ppm)	0.2
Mn (ppm)	19
Zn (ppm)	<1
B (ppm)	<0.1
TOTAL N (%)	0.02

[1] pH of soil at the end of the experiment.

Table 6.2 Basal fertiliser

Element	Source	Rate
N	Urea[1]	60 kg N/ha[2]
P	Triple superphosphate[3]	30 kg P/ha
K	Potassium sulphate[1]	75 kg K/ha 30 kg S/ha
Mn	Manganous Sulphate[1]	5 kg Mn/ha
Cu	Cupric Sulphate[1]	2 kg Cu/ha
Zn	Zinc Sulphate[1]	2 kg Zn/ha

1. Laboratory grade chemicals
2. Applied at sowing, 31 DAS and 43 DAS
3. Finely ground

Table 6.3 Seed and water analysis

Bore Water	
pH	7.0
Ca (ppm)	107
B (ppm)	<0.1[1]

[1] Further analysis indicate B level 24 ppb.

Seed	Boron content
Yori 77	8 mg/kg

Table 6.4 Boron toxicity symptoms in sesame

Treatment (mg B/kg soil)	Symptoms
0	No symptoms
1	No symptoms
2	lower leaves, marginal necrosis
3	progressively more severe necrosis
4	premature leaf drop of the most severely affected leaves

Table 6.5 Yield components of sesame

Treatment (mg B/kg soil)	Plant height (cm)	Plant biomass (g)	Capsule number per plant	Seed weight per plant	Shoot/root ratio
0	141.6	33.4	77.7	7.66	0.87
1	133.9	33.0	85.5	8.92	1.43
2	126.0	25.3	60.4	7.08	1.35
3	122.9	24.7	66.3	7.46	2.48
4	123.6	21.9	59.2	6.57	2.42
LSD (5%)	9.18	6.42	17.14	1.96	1.36

Table 6.6 Partitioning of 300 seed weight.

Treatment (mg B/kg soil)	300 seed weight (g) Plant position			
	Top	Middle	Bottom	Branches
0	0.78	0.84	0.84	0.87
1	0.80	0.82	0.87	0.89
2	0.85	0.87	0.87	0.89
3	0.84	0.88	0.89	0.86
4	0.80	0.91	0.92	0.91
Mean	0.81	0.87	0.88	0.88
LSD (5%)	N.S.	0.07	0.05	N.S.

Table 6.7 Partitioning of large bold seed number per capsule.

Treatment	Number of bold seed per capsule Plant position			
(mg B/kg soil)	Top	Middle	Bottom	Branches
0	N/D	35.9	36.3	33.0
1	N/D	37.1	40.4	32.6
2	N/D	40.9	39.6	42.6
3	N/D	38.4	40.6	36.7
4	N/D	35.8	38.3	36.4
Mean	N/D	37.6	39.0	36.3
LSD (5%)		N.S.	N.S.	N.S.

N/D = not determined as difficult to identify numbers of shrivelled seed.

Table 6.8 Partitioning of seed weight per plant.

Treatment	Weight of seed (g) Plant position.			
(mg B/kg soil)	Top	Middle	Bottom	Branches
0	0.27	2.49	2.67	2.24
1	0.20	2.90	3.69	2.11
2	0.23	2.42	2.55	1.89
3	0.22	2.56	2.96	1.73
4	0.13	2.35	2.71	1.39
Mean	0.21	2.54	2.92	1.87
LSD (5%)	N.S.	N.S.	N.S.	N.S.

Table 6.9 Boron uptake of sesame seed.

Treatment	Boron uptake (microgram) Plant position				
(mg B/kg soil)	Top	Middle	Bottom	Branches	Total
0	2.16	17.42	26.70	15.68	61.96
1	2.40	26.10	44.28	21.10	93.88
2	2.53	29.04	33.15	26.46	91.18
3	3.08	33.28	41.44	17.46	95.26
4	1.43	25.85	29.81	15.29	72.38
Mean	2.90	32.93	43.85	23.96	

Appendix 1

Method of Analysis

Metolachlor

The sample is extracted by blending with acetonitrile. After filtering the extract is de fatted with hexane and then partitioned into hexane. The residue is filtered through an alumina column before GLC analysis with ecd.

References

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Trifluralin

Seed-Extraction as for Metolachlor with florisil clean up.

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